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A Cast-Iron Session

The reduction to half a day of the time for discussion of Papers at the forthcoming meeting of the Iron and Steel Institute, inevitable under present conditions, cuts down the number which can be presented personally by their authors. The foundry industry is therefore honoured that the first choice should have fallen on two Papers on pig-iron and cast iron. The author of these, Mr. H. Morrogh, is attached to the staff of the B.C.I.R.A., and both Papers have been, or are being, reproduced in our columns. The shorter, "The Polishing of Cast Irons and the Metallography of Graphite Flakes," relates to a method of polishing cast irons in such a way that the graphite is left intact for examination instead of being torn out by friction, and thus rendering possible examination of the graphite structure. The longer Paper, "The Metallography of Inclusions in Cast Irons and Pig-irons," deals with the study of inclusions, their identification and properties, as actually seen under the microscope.

The other subject for discussion closely concerns the same subject of inclusions, since it is the third report of the Oxygen Sub-Committee, originally set up for the purpose of measuring the nature and amount of the oxide inclusions in steel. The methods adopted were originally two in number, the so-called residue method and the vacuum fusion method. In the residue method, the metallic part is dissolved away by a solvent, usually an alcoholic iodine solution, or chlorine, which does not attack the oxide inclusions which are left as a residue capable of analysis. This yields the several oxides of iron, silicon, manganese and aluminium. In the vacuum fusion method the sample is so treated that the amount of oxygen combined in all these is given as a single figure, which, of course, should check the sum obtained from the residue method. More recently the so-called aluminium reduction method has been devised to give a similar figure for total oxygen combined as oxides.

The Oxygen Sub-Committee's report contains some sixteen Papers, of which three concern pig and cast irons. Mr. Pearce, in one of them, explains how, in applying the above methods to pig and cast iron, unexpected difficulties were met, and it was not until modifications were worked out that they were used satisfactorily. Mr. E. Taylor Austin gives the residue and aluminium reduction methods as applied to pig and cast irons in their latest form. The figures obtained for a group of pig-irons are of considerable interest, for they show very small figures indeed for alumina and manganous oxide, while those for silica and ferrous oxide are larger.

It will be recalled that a few years ago the question of inclusions was on the lips of every foundry metallurgist. It was supposed, with quite fair presumption, that they played a definite part in the precipitation of graphite, and this was a major reason why it became important to try and find what they were and how irons differed in respect of the nature and quantity present. These Papers thus mark a definite step forward, but where do they take us?

The residue method tells us that there are present ferrous-oxide and silica, and smaller quantities of manganous oxide and alumina. These are not necessarily present in this form, but may be in the form of silicates. The residue method says nothing about sulphides, because these are dissolved away by the solvent, but since sulphur is easily determined by direct chemical analysis, the amount of sulphide can be estimated with fair accuracy. Now oxides arising from the presence of alloy elements such as chromium have not yet had full attention, and there are other elements such as titanium also determinable, but probably present in the metal as carbide and not oxide.

The microscopic approach can, in the nature of the case, not show anything in solution, or anything so finely divided that it is submicroscopic, such as the silicate slime which we heard so much about at one time. But what the microscope does show, however, is actually there in the form in which it is seen, and from this point of view the sulphides form a most important inclusion. Apart from these, it is found that titanium inclusions, of various forms, are so common that their presence must be regarded as normal. The most extraordinary result, however, is that there is no microscopic evidence in normal materials of the presence, either as oxide or silicate, of iron, manganese or aluminium. This provides a puzzle which will exercise the wits of many metallurgists, and from it further advance is bound to come. Where is the evidence of the oxide which we may presume to be the result of oxidised metal? Oxidation is commonly alleged to take place in many melting processes and, if it occurs, some evidence of it should be there. Furthermore, silicates, aluminates, may be expected to be present from slag or silica or alumina from sand. It is clear that the whole conception of inclusions and of their effect on the metal is about to enter on a new phase.

Pointers on New Income Tax Impositions

Although the new standard rate of tax as declared by the recent Budget is now 10s. as against 8s. 6d., it must be remembered that large numbers of taxpayers will not pay at this rate, as a reduced rate of 6s. 6d. (as against 5s.) applies to the first £165 of taxable income (meaning total income less personal allowances), thus if all income is earned a single person does not pay this 10s. poundage unless total income exceeds £272 4s. 4d.; a man with wife £338 17s. 9d.; a man with wife and one child £394 8s. 10d.; a man with wife and two children £450. With total income at these figures, the taxable income, after deducting the relevant personal allowances, would be £165, thus each such taxpayer would pay a total tax of £53 12s. 6d. (£165 at 6s. 6d.).

The personal allowances are earned income allowance one-tenth (from one-sixth), each individual £80 (from £100), for wife £60 (from £70), for each child £50 (no change).

Every person is exempted from tax paying if total income (earned or investment) does not exceed £110 (changed from £120). Moreover no tax is payable by a man with wife, all earned income, unless total income exceeds £155 11s. 1d., man with wife and one child £211 2s. 2d., and man with wife and two children £266 13s. 4d., the relevant personal allowances leaving taxable income "nil" in each case. Formerly these classes of taxpayers were outside taxpaying with total incomes (earned) of £204, £264, and £324.

Items of Interest

A novel feature has been introduced, so that although the lowering of the personal allowances means more taxpaying, nevertheless a refund of any tax payable by virture of these reductions will be made after the war to each taxpayer so concerned.

Under the Concentrating of Industry schemes, the nucleus firms, who will manufacture for displaced firms, will not be liable for tax on profits which are payable to the displaced firms, these firms being assessed with tax on the profits amount received.

The incidence of the Excess Profits Tax, which is 100 per cent. of assessed excess profits, has been altered, so that 20 per cent. of the amount paid in tax will be available for the firm concerned after the war, but this 20 per cent. produce will be liable to income tax, and this applies by virtue of the following. E.P. tax payments are deductible as trading expenses for income tax, therefore with the return of 20 per cent., that amount cannot be an expense, but income, and so will automatically become chargeable with income tax.

The three income tax allowances, for depreciation, the "wear and tear" rule, the "obsolescence" rule and the "renewals" rule, are unaltered, and an additional allowance will apply for buildings, machinery and plant—provided since January 1, 1937—which may be considered as having depreciated in value or become redundant, with the ending of the war and pending a final settlement, yearly allowances will be given before the end of the war, where the case would obviously meet the required conditions.

The new tax poundages will apply in relation to income in year ending April 5, 1941, that is for Schedule D (business profits; persons on own account) and Schedule E (employments), although under "D" an earlier year ending date can be substituted according to the accounting year ending date of the firm concerned (*e.g.*, December 31, 1940). Payments arising from these assessments will be made under Schedule D at new rates on January 1, 1942, and July 1, 1942; under Schedule E deductions from salaries are now made at each pay day, and the new rates will apply from November 1, 1941. Employees, however, coming within the official term "weekly wage earners," that is manual workers, will come upon the new rates January 1, 1942. In cases of deductions at source, dividend payments and the like, the new rates will apply to all deductions made from April 5, 1941.

Where a person as regards earned income has been "hit by the war," he can claim to be assessed on current years income (*i.e.*, year ending April 5, 1942) instead of preceding year's income (*i.e.*, year ending April 5, 1941) as ordinarily applies; relief in these cases will be given with the July 1, 1942, payment or by repayment.

Photometric Estimation of Niobium and Tantalum

Report No. 143 of the chemical sub-committee of the Verein deutscher Eisenhüttenleute, by G. Thanheiser, published in the "Archiv für das Eisenhüttenwesen," deals with the photometric estimation of niobium and tantalum, present together and in association with titanium, in steels, ferro-alloys and slags. Niobium is estimated by the yellow coloration formed by niobium with hydrogen peroxide in a concentrated solution of sulphuric and phosphoric acids. With a suitable mixture of the two acids, the coloration due to titanium can be almost completely suppressed, making niobium estimation independent of any titanium which might be present. Only when the Ti exceeds 1 per cent. does a slight correction of the niobium value found become necessary. Photometric estimation of Ta is based on the yellow coloration produced by Ta with pyrogallol in a 3 per cent. ammonium-oxalate solution. Ti also gives a yellow coloration with this solution; it must be determined independently of the niobium and Ta, and a suitable correction made in the Ta value found. Ti is estimated with chromotropic acid (1:8-dihydroxynaphthalene-3:6- disulphonic acid) in the same solution.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Supply of Trained Welfare Workers

To the Editor of the Foundry Trade Journal.

Sir,—Recent utterances by the Minister of Labour have served to stimulate interest in industrial welfare work, and many firms are now considering the appointment of a welfare or personnel worker. Unfortunately, as our correspondence shows, many of those so appointed know little or nothing of the duties involved and are without any previous factory experience.

Some months ago the Ministry gave approval and financial support to suitable courses on the subject at the Universities of Birmingham, Cambridge, Edinburgh and Liverpool, as well as practical training in the welfare departments of factories. As a result a number of qualified candidates, both men and women, are now available to take up posts in industry.

May I therefore suggest to employers and others who contemplate making appointments of such persons that they should first communicate either with the Factory and Welfare Department of the Ministry of Labour, Cleland House, Paige Street, S.W.1, or the Industrial Welfare Society.—I am, Sir, yours, etc.,

Robert R. Hyde.

Industrial Welfare Society, 14, Hobart Place, Westminster, S.W.1.

April 16, 1941.

Random Shots

A young lady in her early 'teens, obviously of the type who wishes hard that she were old enough to throw away all her school books and "go on the land," was travelling in a bus with her father, who pointed out to her a very large and imposing building: "that, my dear," said he, wishing to impress the young lady, "is X. Y. College for Women. I'd be very proud if you were clever enough to go there when you are older." "Humph," came the disappointing reply. Then all at once she spied a cemetery close by, and suddenly brightening up she added: "And I suppose that's where they bury the students who work too hard!"

* * *

And, indeed, who could blame the youngster who, having an inherent love of the country and delighting in flowers possessing such captivating names as old man's beard, pick-pocket, ragged robin, and stinking Willy, should suddenly find herself face to face with Botany-as-it-is-done-at-College? For, after reading the following extract from a botanical treatise one begins to feel that there is something in that cemetery idea, after all. This is how it goes:—

Characters. Rhizome, in pieces about 4 to 8 centimetres long and 5 to 10 millimetres thick, subcylindrical and dorsiventrally somewhat flattened, usually slightly curved and embranched . . . . transversely cut surface showing a dark cortex about 1 millimetre wide, a well marked cambium line, a diffuse ring of about 10 to 12 pale xylem bundles separated by dark medullary rays, and a large dark pith about 3 to 6 millimetres in diameter; periderm, consisting of a phellogen and of several layers of tabular thin-walled cells . . . . odour strong and reminiscent of iso-valeric acid; taste, bitter and somewhat camphoraceous.

Phew!

* * *

Since the introduction of the Purchase Tax secondhand goods have come into their own once again, only to receive a new setback by the introduction of the World's Stiffest Budget, which is succeeding in doing what it aims at—the drastic reduction of spending power. However, anyone with initiative need not be disconsolate, and he who desperately wants some article that cannot be put down as a sheer necessity is not to be beaten. All he has to do is to find something that was and no longer is a favourite possession and offer it in exchange for the coveted treasure of the moment. Thus one reads of someone willing to exchange a violin for a set of golf clubs. Obviously the violin was the boon companion of his bachelor days, and the golf clubs, apparently, are to be the companion of his married days, since his wife is in the W.V.S.! Another is willing to exchange a ventriloquist's doll for a good wireless set or a perambulator. This, of course, is a wife whose husband has given up "the Halls" and gone to be a soldier, whilst she, poor woman, finds the home too dreadfully quiet without him. Yet she cannot make up her mind which sort of noise to instal in his place—whilst a baby would undoubtedly last longer, it is a distinct advantage to be able to shut off a noise by merely turning a knob.

* * *

Answers to last week's quiz:—

(*a*) A name given to Hanseatic merchants who traded in this country during the middle ages. A word from which sterling is derived.

(*b*) A bit of first aid equipment.

(*c*) Good ordinary brand; British Standards Institute; Board of Trade; Directorate of Technical Development; cold-rolled—close-annealed; British Non-Ferrous Metals Research Association.

"Marksman."

The South African Engineering Industry at War

INFANTRY MORTAR BOMBS

By A. G. THOMSON, Editor of "Engineer and Foundryman"

There are two distinct methods by which field mortar bombs are at present being cast in South African foundries. Attention is also being given to the possibilities of various other processes, which include the forging of bombs from solid billets. Quite apart from the problems affecting the actual manufacturing methods to be employed were those presented by the sudden introduction of production work as distinct from jobbing work. "If anybody had told me before the war that within a few months we should be turning out anything by the thousand I should have laughed." This remark was made by the technical expert of a prominent Reef concern where to-day the weekly production of mortar bombs by the sand mould method runs well into four figures. "For a jobbing firm to switch over to mass production is a very considerable undertaking," emphasised this expert as he conducted the writer round a building which had been specially erected and equipped for the production of bombs.

Sand Casting Method

As an instance of the enthusiasm and energy with which commercial firms have embarked on munitions production, it may be added that this workshop was erected in about six weeks; no small achievement when it is considered that the building is 213 ft. long by 52 ft. wide, stands 45 ft. high and contains 13 large bays. The equipment provided specially for the production of mortar bombs includes six core-blowing machines, six shot-blast apparatus, four drying ovens, four power saws, a sand-milling machine and mechanical screen, a test-bench and pump, and casting racks.

The simplification and reduction of all operations to a minimum was essential in order to ensure maximum output with the least room for error. This necessitated considerable planning beforehand in regard to layout, pattern, sand, moulding box design and construction, pouring methods, fettling arrangements, etc. A proper flow-through had to be secured by the avoidance of any bottle neck in the various stages of manufacture from moulding, drying, closing, pouring, etc., to stripping, fettling and annealing.

The steel for the castings is made in 7-ton Héroult electric furnaces which are running continuously throughout the 24 hours for seven days a week. This steel is a special composition approved by the Director-General of War Supplies, and test-bars are cast with every batch of metal in order that the inspector can satisfy himself that it complies with specifications. The bombs are cast in racks of thirty, and as many as 26 runs of thirty have been cast at a single heat. The metal is poured in at one end and runs right through, filling each mould as it passes along the rack. After casting, the clamps are knocked off and the moulds are stripped, the bombs emerging in long strings. The runners are cut off by oxy-acetylene flame. The interiors of the bombs are then cleaned by special shot-blast machines. From the grinders the castings go on to the test-benches, where they are tested at an air pressure of 120 lbs., after which they are cleaned up in readiness for dispatch to various machine shops on the Reef.

Only sand moulds are used in this establishment, and all cores and runners and launders are made in core-blowing machines. All the sand is mixed in a mechanical sieving apparatus, the total output of which is in the vicinity of thirty tons a day.

It should be emphasised that the entire process of manufacture has been evolved by the firm concerned, with no advice from overseas experts and with no details of the processes used in British or American factories to guide them. A considerable amount of experimental work was involved in the development of the core-boxes and moulds, as well as to determine the most suitable sands and oil binders to use.

The company's first impulse was to cast on the flat, using jolt moulding machines for the moulds. However, an earlier attempt to use this method in executing a small order proved a failure on account of persistent leakage at a point where the casting walls were penetrated by a thin wire used to support the core at the closed end. This scheme was therefore abandoned, and consideration was given to a method on similar lines using the "dumb-bell" principle. In this system two cores are made in one piece, the weight of the one core counterbalancing the weight of the other, and the neck being provided by a substantial length of print. This method was also rejected, mainly on account of the fettling difficulties which the positioning of risers would present.

An alternative to these methods was to fix the core perpendicularly to a metal plate, and use the plate as a seating for the accurate positioning of half-moulds to the core. These were the lines on which the system of moulding was finally developed. To a bottom plate with a female spigot is fixed a length of perforated piping which serves the dual purpose of core vent and support. The core is formed around this piping with the spigot centralising the core box, and remains a fixture on the plate till cast. A male spigot on the bottom of each half-box centralises the mould with the core, while a flat ring slipped over a spigot on the top of the boxes serves the double purpose of clamping and centralising at that point. The spigots position the half-box on the pattern plate. All plates, boxes and rings are accurately machined, the various units being made interchangeable.

For the purpose of rapid production of the cores, a core-blowing machine was the obvious choice, and the application of this machine was extended by arranging to blow up the moulds. It was also decided to pour down the feeder-head, no ingate being provided at the bottom of the mould. From the results of a few test casts no drawback to this method could be found, the castings being sound throughout. An interesting point resulting from the experimental casts was that a single strand of hemp around the core pipe assists very appreciably in the stripping.

In considering the methods adopted, a point which should be borne in mind is that mortar bombs are made by emergency workers under the supervision of skilled men, and it is therefore important that, as far as possible, the risk of unsatisfactory work should be eliminated. This seems to have been achieved to a very large degree by the extensive mechanisation of production, which is evident in such details as string-winders for winding hemp around the core barrels and the special trucks by which cores are conveyed in batches of 175 to and from the drying oven.

In the production of mortar bombs a very high degree of accuracy is required. Certain drawing dimensions give tolerances of plus or minus 25 thousandths of an inch, while the finished weight for the empty casing must be within limits of plus or minus 2 ozs. The specification clauses also call for a hydraulic test of 1,000 lbs., an air test of 100 lbs., maintained for 1 min., and a flight test wherein two bombs from a lot of 500 are fired, and unsteadiness in flight may mean the rejection of the whole 500. Conformity with such close tolerances and severe tests necessitates an accuracy of casting infinitely greater than that which passes for general commercial requirements, while the fine balance needed to assure survival of the flight test demands a very precise exactness and uniformity in wall thickness.

That the system evolved has proved satisfactory is shown not only by the impressive production figures, but also by a very appreciable reduction in the percentage of rejects. Very fine work is also being accomplished in the various factories and engineering workshops, where mortar bombs are being machined to very fine limits of accuracy, and the high figures of production set by the foundries are being well maintained.

The Iron Chill Process

In the workshops of a prominent Reef concern the writer saw mortar bombs being produced by a plant which has a number of unique features and has aroused considerable interest among munitions experts. This firm has pioneered the production of this particular type of bomb, and can also claim to be the first company in the Union to manufacture steel from South African hematite. It may be added that the production of bombs is by no means the only direction in which it is making a substantial contribution to South African defence.

The war effort of the company has involved an expenditure of many thousands of pounds on extensions to plant and premises, all of which have been carried out under the personal supervision of the managing director (who, incidentally, is also the chief engineer), a much-travelled South African with many years' technical experience who has spared neither time nor trouble in promoting the efficiency of his munitions plant. The production of bombs at this factory runs into many thousands weekly, and the percentage of bombs which emerge from the foundry to the finished state in accordance with British Standard Specifications is very high. The company have been congratulated by the authorities not only on the way in which the organisation functions, but also on the very consistent quality of the materials which are being produced.

By good fortune, the writer happened to be present at the casting of 360 bombs in a single blow from South African ores. Very little scrap enters into the composition of the metal. Casting is carried out in permanent moulds by a process said to be unique in South Africa. While waiting for the approach of No. 13 converter with its charge of molten metal, the writer had leisure to reflect that the foundry was certainly among the largest establishments of its kind in the Southern Hemisphere. It also struck him very forcibly that in the intensity of the munitions drive industrialists seem to have banished superstition, for it often occurs that the converters run to the 13th heat, and the Inspector who is permanently stationed with the company uses the official stamp—No. 13. Casting is just as successful on Friday the 13th as on any other day. Actually it was on Thursday the 12th that the writer saw No. 13 blow in

operation, and on this occasion there was certainly no hitch.

Assuming each converter to hold upwards of two tons of metal, the total weight of bombs cast in the foundry that day must have exceeded 26 tons. Immediately after casting the cases were knocked over like nine-pins, the castings then falling out and being at once collected and placed in their respective heat bins. The cycle of casting is completed every 40 mins., groups of 120 bombs being cast during this period at each of three stations. All bombs cast in the establishment are kept in batches according to heats during their progress through the machine shop. An interesting point is that all bomb cores are made by hand from special sand and stoved under perfect heat control.

The bomb-casting squad consists of moulders, sailors, riggers, farmers, wagon-drivers, and, in fact men of all callings, and professions. Practically all the labour is drawn from the rural areas, and 98 per cent. of the men are Afrikaans-speaking. The number of men employed as emergency workers over and above the usual staff runs into three figures. According to the managing director, better men and more loyal South Africans could not be found. Every man in the establishment has taken the oath. Several university students have also rendered valuable assistance during their vacations, working under experienced keymen who have given them practical training in foundry work in respect of munition manufacture. The staff of the bomb foundry includes 19 natives, who seem to have been infected with the general keenness, for even the "carry-on" boys were trotting with their shanks of metal.

A machine shop 300 ft. long by 40 ft. wide is equipped with machinery devoted exclusively to munitions production. Some of these machines have been transferred from other departments of the establishment where commercial work has been subordinated to the requirements of defence, while others have been imported specially from Britain or the United States. The machine-shop is exceptionally well lit and ventilated, while space and cleanliness are outstanding characteristics of the premises. A striking indication of the quality of the work performed was afforded by the shavings from a cut off a 3-in. forming tool on the nose end of a bomb, which were peeling off like butter. Work in the machining department is being carried on 24 hrs. a day on seven days a week, and this programme will be continued until orders are received to stop.

The machining of the bombs is very carefully controlled throughout. After being ground internally the bombs pass on to a weighing scale, where they have to conform to a specified weight. After passing the very rigorous scrutiny of the factory's own inspectors, they arrive at a specially constructed table where the Government Inspector takes over for final inspection and stamping.

The sequence of production is as follows: From the foundry to the sand-blasting machines, and thence to the saws, from the saws to the hydraulic tables and thence to the various machining operations; from the machining operations to internal grinding operations, and then on to the weighing scale; from the weighing to a staff inspection, followed by a final test, the stamping operation, and a general review by the Government Inspector. After this ten bombs are selected out of every thousand for fragmentation—a test conducted on the property. The finished articles are packed in containers to await transport by military wagon to the assembly works. A full load of bombs leaves the factory daily.

A final point which may be mentioned is that owing to shortage of engine lathes within the organisation, and with the co-operation of the War Supplies Board and the Munitions Production Committee of the Chamber of Mines, the company have been permitted to send bomb chill moulds for machining to various mines belonging to one or other of the Witwatersrand mining groups. These facilities have materially assisted in augmenting production, and are greatly appreciated by the managing director. At his special request the writer would like to mention the valuable services rendered by heads of all departments, the staff, and especially the company's chief munitions inspector, aged 66, whose job is to see that all machined bombs emerge according to specification under his direct supervision. The inspector has expressed a desire to continue as long as the war lasts, after which he anticipates taking up permanent retirement.

As might be expected, the factory is very carefully guarded, a number of sentry boxes being located at central and extreme points of the property, all fitted with contact switches connected to several alarm sirens. The area of the property, about fourteen acres, is beautifully situated, and the organisation generally is a credit to South Africa.

Production of Springs for Fuses

The casting and machining of the castings are, of course, only two stages in the manufacture of field mortar bombs. Another important section of the work is the production and assembly of the fuses, one type of which actually contains nineteen component parts. Since the production of these components is distributed among a large number of different workshops throughout the country, it may be said that a very large section of the industry is taking a direct part in maintaining the very considerable output of field mortar bombs.

A particularly good instance of the extensive co-operation required is provided by the tiny springs which are among the most important components of the fuse mechanism. One type of fuse contains no fewer than five springs, on the efficient functioning of each one of which depends the effectiveness of the bomb. The wire for making these springs is now being drawn and tinned in South Africa—an achievement which is not the least striking of its technical triumphs, particularly when it is considered that the finest wire used is 0.009, and that all wire for spring making has to be conditioned. To-day very little wire trouble is being experienced.

Mass production of springs had never been attempted in South Africa before the war. In fact, eighteen months ago an order for 5,000 small springs of the same type would have been considered exceptional. The first order for springs for bomb fuses ran well into six figures and called for five different types. The contractors started production with a type of hand-machine which they had been using for about ten years, but it was soon realised that months would elapse before the order could be completed by this process. After careful consideration it was decided that semi-automatic machines were the most suitable for the purpose. The manufacturer therefore set to work to design and build his own semi-automatic machines, and within a period of slightly over five months not only had his machines in operation but was actually able to deliver the complete order.

As an indication of the nature of the undertaking it may be mentioned that 20,000 springs of one of the types called for in the initial order weigh no more than a pound. Yet the tolerances required are very fine. The springs have to be made to limit gauges in both diameter and length, and in addition must pass a final weight test. This very high standard of accuracy is essential, since a variation of even 1/1,000 in. in the diameter of the wire of which the spring is made might upset the entire mechanism of the fuse.

British Standards in Wartime

Some months before the outbreak of war, the British Standards Institution, which is the recognised centre for the promulgation of all national British Standards, offered H.M. Government the services of the Institution, as a complete unit, in the national emergency. This offer which was sent to the Board of Trade through whom the B.S.I. receives its Government grant, was most cordially received, and the various Departments of State were duly informed of the proposal.

On the outbreak of war the B.S.I. realised that its peacetime procedure was inadequate to deal effectively with the demands imposed by the changed conditions, and especially by the need for rapid action. A number of small executive committees were therefore set up for the various sections of its work, these being made fully responsible for the preparation of any War Emergency Specifications the Institution might be called upon to undertake. Under this emergency procedure the executive committees were given authority to restrict the usual wide consultation of industry to those interests directly concerned, and the reduction of the time usually given for comment on draft standards. It is, of course, understood that any British Standards issued under wartime procedure will come under review directly peace comes again.

Government Departments are employing the B.S.I. machinery for the preparation, co-ordination and promulgation of War Emergency Specifications to meet their several requirements, that policy being adopted because of the great experience of the Institution in this field and because it provides a most effective liaison between them and almost all branches of British industry.

Alpine Montan Progress

The report for 1939, recently issued, of the Alpine Montan A.-G. Hermann Goering, Linz, the principal Austrian iron and steel and coal company, which came under the control of the Reichswerke Hermann Goering soon after the annexation of Austria, shows that the incorporation of the concern in the industrial structure of the Reich has continued to proceed satisfactorily and that the plans made for the expansion of these works at the outset of the war have fully materialised insofar as mere production figures go. The outputs of iron ore, pig-iron, rolled products and coal reached new records during 1939, and progress continued to be made in works' extensions and the provision of new plant. It is pointed out, however, that the quantitative output of these works has not by any means been comparable with the extra capacity added or the new capital sunk in these extensions. The iron and steel price question is also still a vexing one, for in 1938 prices in the Ostmark were reduced to the same levels as in the Reich, calling for cuts of 25 to 40 per cent., and in certain products even of 60 per cent., while production costs have remained in a very uneconomic relation to sale prices and cannot be reduced to comparable levels until the whole of the new plant is in operation under the same conditions as obtain in the Reich steel industry. Continuing its traditional policy, the Alpine Montan is concentrating on the production of quality steels, a trend which has been closely determined by the high grade of iron ore available. The labour question has been given attention and large apprentice workshops have been provided where about 1,000 youths are in training. The net loss for the year was 5,420,100 Rmk., which has been covered from the reserves. At the annual meeting in January the share capital was raised from 40 to 180 million Rmk., giving a rough indication of the finance requirements of further extensions.

Unsoundness in Gravity Die-Cast Silicon-Aluminium Alloy Pistons

By R. T. PARKER, B.Sc., A.R.S.M.

(*Continued from page* 258.)

EFFECT OF DIE-ASSEMBLY TEMPERATURES UPON THE SOUNDNESS OF PISTONS

It had been observed, as already stated, that in certain cases pistons which were superficially sound, that is, which had passed the machining test, had been found to contain unsoundness displaced towards the inner surface of the skirt. It was felt that this effect might be the result of differences in the temperatures of the die and core, and the work described in this section was carried out to investigate the effect of known variations in such temperatures. As the work proceeded, it became evident that the gas content of the metal was also playing a part in determining the mode of occurrence of unsoundness, and the work was extended to compare the results of using metal of low and high gas content under known temperature conditions in the die-assembly.

Experimental Work

A standard die-assembly was selected and fitted with two Chromel-Alumel thermocouples, one in the die and the other in a section of the core. The junction of the former was placed within one-sixteenth of an inch of the molten metal surface, and the core couple was opposite to it, in a copper plug running to within one-sixteenth of an inch of the metal surface. The portion of the piston between the thermocouple junctions was about halfway between one of the gudgeon-pin holes and the bottom of the skirt—the region where unsoundness had been found to occur.

Another thermocouple was put into the molten metal used for casting, and with the aid of a three-way switch temperatures in the die, the core, and the molten metal could be taken within a few seconds of each other. Temperatures were taken immediately before metal was poured into the mould.

The casting was carried out by a caster normally engaged in the daily routine production of pistons. The only restraint placed upon him was to prevent his own adjustment of the temperatures of either the feed metal or the die assembly. Two experiments were necessary, one being made with metal of high gas content, and the other with metal of low gas content. The compositions of the two batches of metal were as follow:—

Table I.—*Composition of High- and Low-Gas Metal.*

	High-gas metal.	Low-gas metal.
	Per cent.	Per cent.
Copper	0.91	0.94
Iron	0.53	0.41
Manganese	0.02	0.02
Magnesium	1.02	1.15
Silicon	11.72	11.86
Titanium	0.10	0.03
Nickel	2.53	2.39
Sodium	0.001?	0.0018

The high-gas metal was prepared by ordinary methods, that is, it was produced by melting pig in an oil-fired furnace, and transferring metal from this furnace to an oil-fired maintaining pot, open to the atmosphere. The low-gas metal was prepared by remelting pig in an electric furnace. When the metal had reached about 700 deg. C., it was allowed to remain for 1 hr. with a gentle stream of nitrogen from a cylinder playing on the surface of the bath, the furnace being closed as far as the gas inlet pipe would allow. Casting in this case was made straight from the furnace.

Results

Twenty-three pistons were cast in high-gas metal, and 31 in low-gas metal. The former have been numbered 537 to 566 inclusive, and the latter group numbered 1,191 onwards, and alphabetically for X-ray examination.

In classifying the die and core temperatures as hot or cold, the following purely arbitrary grouping was adopted:—

Cold core	up to 349 deg. C.
Medium core	350 to 39[illegible] deg. C.
Hot core	[illegible]0 to 450 deg. C.
Cold die	up to 319 deg. C.
Medium die	320 to 369 deg. C.
Hot die	370 to [illegible]2 deg. C.

Tables II and III give details of pistons falling within the nine groups obtained by combining the temperature classes indicated above. Details of the temperature of the die-assembly and of the metal; the amount, type, and position of unsoundness in two microsections from the

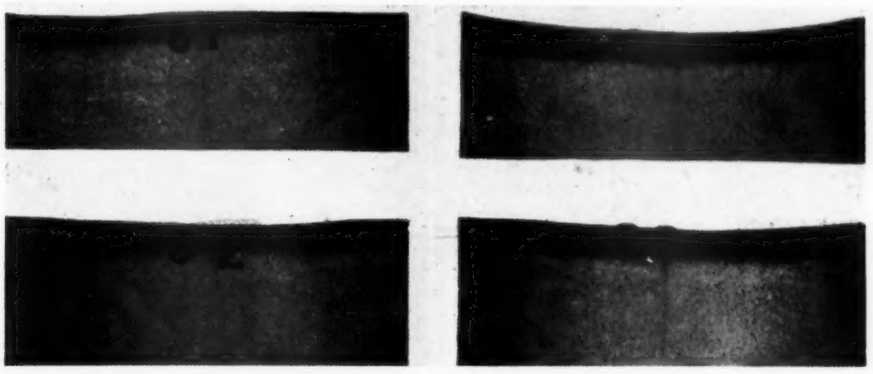


Fig. 5.—X-Ray Prints of Typical Pistons.
Piston S—Cold Core/Hot Die Group. Low Gas Metal.
Piston 556—Cold Core/Hot Die Group. High Gas Metal.

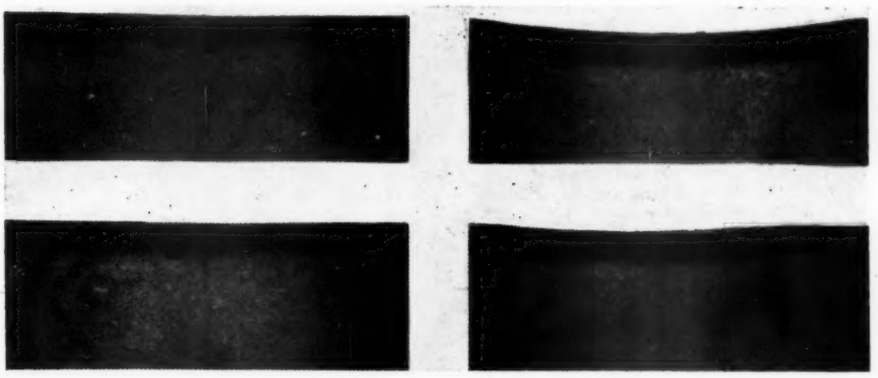


Fig. 6.—X-Ray Prints of Typical Pistons.
Piston D—Medium Core/Cold Die Group. Low Gas Metal.
Piston 565—Medium Core/Cold Die Group. High Gas Metal.

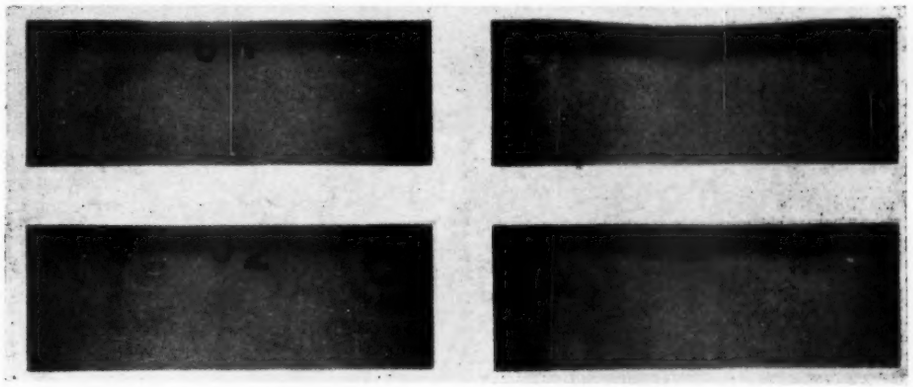


Fig. 7.—X-Ray Prints of Typical Pistons.
Piston 0—Hot Core/Hot Die Group. Low Gas Metal.
Piston 554—Hot Core/Hot Die Group. High Gas Metal.

skirt; and the results of X-ray examination of two positions in the skirt of each piston are collected together.

X-ray Examination

The most striking feature of the X-ray examination is the wide variation in soundness shown by the different groups of pistons.

High-gas Metal Pistons.—The best pistons were in the hot core/hot die and medium core/medium die groups, with a few exceptions. The worst pistons were in the medium core/cold die group and the unsoundness appeared to be fairly coarse. The two groups with cold cores were both poor, while the medium core/medium die and medium core/hot die groups were rather better. Prints from X-ray films of typical specimens are given in Figs. 5 to 7.

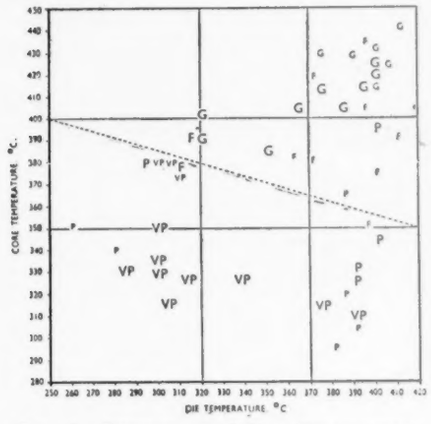


Fig. 8.—Results of X-Ray Examination of Pistons.
VP = Very Poor; P = Poor; F = Fair; G = Good.

Low-gas Metal Pistons.—The soundest pistons were again found in the hot core/hot die and medium core/medium die groups, although those in the hot core/medium die group were also quite good. All those pistons in cold core groups were unsound to a greater or lesser degree, while the medium core/cold die group varied from poor to fair. X-ray prints of typical pistons are given in Figs. 5 to 7.

In both experiments the soundness of the pistons appeared to improve with increasing die-assembly temperatures. On comparing the X-ray prints of pistons cast in the two experiments, it will be seen that there is a marked difference in the size of the cavities. In the cold core/hot die groups of both experiments there is marked unsoundness, but that in the low-gas metal is coarser and more localised than in the pistons cast from high-gas metal. In the pistons of both experiments cast in the hotter assembly the unsoundness is small in quantity, the low-gas metal producing pistons of greater apparent soundness—in fact, little fault can be found with them.

Fig. 8 shows the relation between die and core temperatures and soundness of the piston skirt. The improvement at higher assembly temperatures is clearly shown. The diagonal broken line across the medium core groups roughly divides the diagram into zones of good and bad pistons.

Micro-Examination

Specimens for micro-examination were taken from representative pistons. Two were taken from each piston, one from a position between the thermocouples, and the other from the corresponding position under the gudgeon-pin hole on the opposite side of the piston.

An area extending from the bottom of the skirt to the gudgeon-pin boss was examined in each case, the polished plane being at right angles to the surface of the piston and parallel and about ¼ in. away from the core-sections junction, which can be seen as a fine black line across the X-ray prints. The collected observations for each group are given in Tables II and III.

In both experiments the unsoundness became increasingly fine as the assembly was used hotter. With the metal of high-gas content the hot-core/hot-die group gave pistons with some fine, generally distributed unsoundness, while the low-gas metal gave pistons with little to very little fine unsoundness.

In the more unsound specimens made with the colder assembly, the observations made by X-ray examination were confirmed, the low-gas metal giving coarser, larger, and more isolated areas of unsoundness (Figs. 9, 10 and 11).

The differences observed in examining micro-sections were at no time as pronounced as those shown by X-ray examination, and to investigate this point sections from piston 554 (hot-core/hot-die group) and 565 (medium core/cold die) were taken parallel to the piston surface. These specimens, examined at right angles to the surface, had shown some variation in both size and degree of unsoundness, but the specimens taken parallel to the surface showed a much greater difference, the colder assembly producing a coarser, larger area of unsoundness (Fig. 12). This suggests that much of the unsoundness is, as might be expected, of far greater dimensions in the plane of the curved surface of the piston.

Fig. 9.—Piston 1192, showing Localised Unsoundness. Low-Gas Metal, Cold Assembly. × 4.

Fig. 10.—Piston 550, showing General Unsoundness. High-Gas Metal, Cold Assembly. × 4.

Table II.—*Results of Examination of Pistons Cast from High-Gas Metal.*

Piston no.	Temp. of metal. Deg. C.	Temp. of core. Deg. C.	Temp. of die Deg. C.	Unsoundness by micro-examination. Amount.	Size.	Position.	Unsoundness by X-ray examination.
				Cold core–cold die.			
550	655	340	280	Little to very little	Fine.	General or middle.	Poor.
542	—	350	260	Little to medium.	Coarse.	Towards core.	,,
				Cold core–medium die. None.			
				Cold core–hot die.			
556	660	320	385	Medium to little.	Fine.	General or towards die.	Poor.
539	670	305	390	Very little to medium.	,,	Middle.	,,
540	655	296	380	Very little to little.	,,	,,	,,
				Medium core–cold die.			
564	684	380	300	Medium to little	Coarse and fine.	To core.	Very poor.
565	685	380	305	Very little to medium.	Fine and coarse.	To core and middle.	,, ,,
566	685	375	310	Medium.	,, ,,	Middle.	,, ,,
				Medium core–medium die.			
559	690	382	362	Little.	Fine.	General.	Fair.
				Medium core–hot die.			
557	—	365	385	Little.	Very fine.	General.	Fair to poor.
562	672	375	400	,,	Fine and coarse.	Middle or general.	,, ,,
563	675	350	395	Medium to little.	Fine to coarse.	General.	,, ,,
538	—	390	410	Very little to medium.	Coarse.	Middle.	,, ,,
541	655	380	370	Very little to little.	Very fine.	General.	,,
				Hot core–medium die. None.			
				Hot core–cold die. None.			
				Hot core–hot die.			
551	655	420	370	Little.	Fine and coarse.	General.	All fairly good under X-ray except. 551, 553 and 555, classed as fair.
552	655	430	375	Little to medium.	,, ,,	,,	
553	663	435	395	Very little.	Fine to very fine.	,,	
554	665	432	400	Little to very little	,, ,,	,,	
555	665	405	395	Medium.	Fine and coarse.	Towards core or general.	
558	678	425	405	Very little.	Very fine.	—	
560	695	428	390	Little.	Fine.	General.	
561	670	442	412	Medium.	Very fine to coarse.	General or middle.	
537	670	415	400	Very little.	Very fine.	Towards die.	

The disadvantage of examining all the specimens by this method was that, in order to establish any displacement of unsoundness through the skirt by variations in die-assembly temperature, it would have been necessary to inspect successive depths below the cast surface.

In investigating this latter point by examination of specimens taken at right angles to the surface, it was found that a great proportion of the specimens had unsoundness, which was general or about in the middle of the section. Quite a number of specimens contained unsoundness found nearer to the core than to the die, and this was established in both qualities of metal, generally when using a cold die. In none of the groups was there any tendency for unsoundness to be segregated towards the die, probably on account of its greater mass compared with that of the core. Cooling the die had a much greater effect upon the distribution and degree of unsoundness than had a similar variation in core temperature.

Examination of microsections from the two groups of pistons showed little difference in dendrite size, so that grain refinement brought about by titanium could be discounted as a possible explanation of the variation in size of the cavities. In comparing the distribution of unsoundness in the pistons cast from the two qualities of metal, the results were obscured by the coarseness of the unsoundness in the pistons of low-gas metal. In most of these pistons no more could be said than that the unsoundness was general or occurred in the middle of the section.

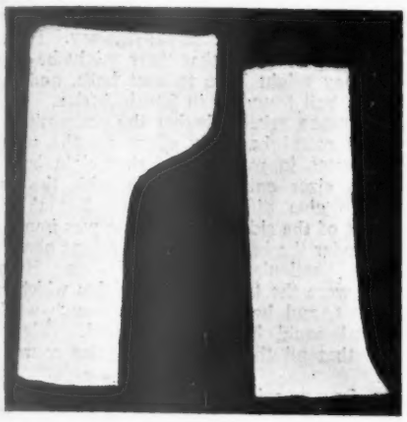


Fig. 11.—Piston 1200, with Little Fine Unsoundness. Low-Gas Metal, Hot Assembly. × 4.

Fig. 12.—Sections taken Parallel to Surface Midway through Skirt. × 4.
a—Piston 556—Medium Core/Cold Die Group.
b—Piston 554—Hot Core/Hot Die Group.

Table III.—*Results of Examination of Pistons Cast from Low-Gas Metal.*

Piston no.	Temp. of metal. Deg. C.	Temp. of core. Deg. C.	Temp. of die. Deg. C.	Unsoundness by micro-examination. Amount.	Size.	Position.	Unsoundness by X-ray examination.
				Cold core–cold die.			
1205W	672	325	315	Medium to large.	Coarse.	Middle or towards core.	Marked unsoundness.
1206X	673	335	300	,, ,,	,,	,, ,, ,,	,, ,,
Y	674	330	300	,, ,,	,,	,, ,, ,,	,, ,,
Z	674	315	305	,, ,,	,,	,, ,, ,,	,, ,,
1193C	680	330	285	,, ,,	,,	,, ,, ,,	,, ,,
				Cold core–medium die.			
1204V	672	325	340	Large.	Coarse.	Middle to towards core.	Marked unsoundness.
				Cold core–hot die.			
1202Q	676	345	400	Small to medium.	Coarse.	Middle or general.	Poor.
R	675	325	390	,, ,,	,,	,, ,,	,,
S	674	310	390	,, ,,	,,	,, ,,	Marked unsoundness.
T	673	330	390	,, ,,	,,	,, ,,	Poor.
1203U	672	315	375	,, ,,	,,	,, ,,	Marked unsoundness.
				Medium core–cold die.			
1191A	685	380	295	Medium to large.	Coarse.	Middle.	Poor.
1192B	680	350	300	,, ,,	,,	,,	Marked unsoundness.
D	680	390	315	,, ,,	,,	,,	Poor to fair.
1195F	680	375	310	,, ,,	,,	,,	,, ,,
				Medium core–medium die.			
1196G	679	390	320	Little.	Coarse with some fine areas.	General.	Good.
1197H	679	385	350	,,	,, ,, ,,	,,	Good to sound.
				Medium core–hot die.			
1201P	676	395	400	Medium.	Coarse.	General.	Poor.
				Hot core–cold die. None.			
				Hot core–medium die.			
1194E	680	400	320	Little to very little	Fine.	—	Good to sound.
1198J	678	405	365	Very little.	,,	General.	,, ,,
				Hot core–hot die.			
1199K	678	415	375	Very little.	Fine.	General.	Sound.
L	678	405	385	,, ,,	,,	,,	,,
1200M	677	415	395	,, ,,	,,	,,	,,
N	677	425	400	,, ,,	,,	,,	,,
O	676	420	400	,, ,,	,,	,,	,,

Discussion of the Results

The original problem which was attacked was the occasional appearance of fine unsoundness in machined pistons. The unsoundness appeared to be common to the entire foundry at certain times, and no connection could be distinctly drawn between obvious factors and the incidence of unsoundness.

As a result of the work which has been described, it was considered that an explanation of the unsoundness both in form and periodicity could be advanced. The explanation of the type of unsoundness that has been encountered is thought to be gas contamination to a variable degree. This must be due to fluctuations in the usual sources of gas contamination, such as changes in atmospheric conditions and in melting practice.

The effect of variation in gas content has been to alter very markedly the form of the gas-shrinkage unsoundness, which is always present to some degree. When the gas content is low, the unsoundness may be easily recognised as being, to a large extent, due to shrinkage, and furthermore such coarse unsoundness tends to be more or less central and less likely to be disclosed by superficial machining. When the gas content was higher, a general type of unsoundness was found, and this persisted although the temperature of the die-assembly was raised appreciably. Increasing the die-assembly temperature with low-gas metal resulted in a rapid diminution of what could be identified as shrinkage.

It is thought, therefore, that although the unsoundness at any time is probably due to both gas and shrinkage operating together, yet gas is the more important factor, being responsible for the appearance of unsoundness on the surface of the machined pistons. It has been shown also that variations in machining technique complicated the problem, since when the unsoundness was fine, the small cavities might be covered by flowing of the surface. This must be one of the factors that explain the periodicity of the unsoundness, and it would account for the fact that unsoundness frequently appears common to the whole foundry.

It will have been seen that the supposition that variations in die-assembly temperatures might be accompanied by significant changes in the position of unsoundness through the skirt of the piston was not confirmed. The investigation has shown, however, that the examination of microsections is by no means sufficient when attacking problems of unsoundness such as the one outlined. This may not be true if some more elaborate way of probing the depth of such specimens is considered worth while; if not, then the use of X-ray examination, with judicious selection of microsections to illustrate the points established by X-ray methods, is by far the more practical method of attack.

Acknowledgments

The thanks of the Author are due to the Northern Aluminium Company, Limited, for permission to publish the results of this work, to Mr. Gordon H. Field for his interest and encouragement, and to Mr. H. G. Hoskins, B.Sc., A.R.S.M., for assistance in the experimental work.

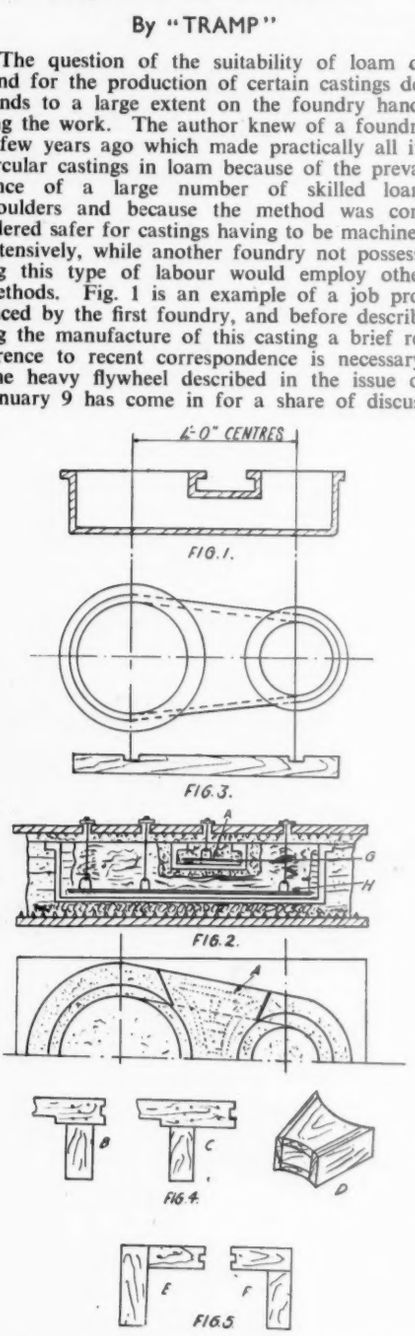
Double-Edged Saw Blade

The Millers Falls Company, Greenfield, Massachusetts, U.S.A., are now marketing a double-edged power saw blade. One edge is slightly narrower than the other and the thicker one is used first so that the other edge rides freely. As soon as the thick edge is worn the blade is turned over and the original thicker edge, being worn, does not retard the work of the thinner edge.

Some Jobbing Foundry Experiences—XXII

By "TRAMP"

The question of the suitability of loam or sand for the production of certain castings depends to a large extent on the foundry handling the work. The author knew of a foundry a few years ago which made practically all its circular castings in loam because of the prevalence of a large number of skilled loam moulders and because the method was considered safer for castings having to be machined extensively, while another foundry not possessing this type of labour would employ other methods. Fig. 1 is an example of a job produced by the first foundry, and before describing the manufacture of this casting a brief reference to recent correspondence is necessary. The heavy flywheel described in the issue of January 9 has come in for a share of discus-



sion, which the author welcomes, as he can appreciate the different points of view of various members of the foundry industry. The question of the guiding of the top was discussed in the issue of January 23, where an alternative method was suggested which consisted of a "fitting guide." The author favours the "feeling guide," originally described on the grounds that with the former a "crush" is more likely to occur on closing. The criticism in the issue of February 20 is partially answered in the opening remarks above, and the author appreciates the method of thicknessing suggested for the dished casting, but maintains that, with the two boards originally supplied, the building of the bottom and cope can proceed simultane-

(*Continued at foot of column three.*)

Notes on Bell Founding

The Paper on the above subject, read at the January, 1941, meeting of the South African Branch of the Institute of British Foundrymen, and reproduced in our last issue, was followed by a discussion, which is summarised below.

Discussion

In thanking Mr. Stones for his very interesting Paper on methods of designing bells, Dr. Van Eck said that he had not previously given very much thought to the subject, and much of what Mr. Stones said was new to him. The Paper showed what care was necessary to obtain good notes. He could think of several famous bells—in particular, the bell in the Kremlin at Moscow, which weighed 250 tons and was the biggest in the world. Unfortunately, this was one of the bells which was not successful, for it broke after casting. What he particularly wanted to find out from Mr. Stones was how the dimensions were originally obtained. Were they worked out mathematically, or did they develop by experience and trial and error? Mr. Stones had mentioned that in order to change the tone metal could be removed from bells. This was another interesting point. With these observations Dr. Van Eck declared the Paper open for discussion.

Mr. Stones said that bell founding was probably one of the oldest arts in the world. He imagined the different sounds had been obtained by practice, not calculation. If the sound was not correct, the tone could be altered by chipping a certain amount of metal from the curve. The sound could be changed either by chipping grooves or by cutting a groove just inside the sound-bow. In the establishment where he used to work, men spent weeks in chipping out 1-8th in. grooves which they thickened gradually until the correct sound was obtained.

In reply to the chairman's remarks on the subject of famous bells, Mr. Stones said that the bells of Westminster were cast in 1856. One of these bells, which weighed 15 tons 8½ cwts. and was 9 ft. 5½ in. in dia., had to be hoisted to 200 ft. The clapper alone weighed 12 cwts. A bell which was cast in Vienna in 1511 weighed 17 tons 14 cwts. and had a diameter at the mouth of 9 ft. 10 in. In regard to the bell at Moscow, the author informed the meeting that another bell was subsequently made which weighed 110 tons and had a diameter of 18 ft. The date of casting was unknown.

Dr. Van Eck inquired whether the bells of Moscow conformed to the formula of dimensions referred to in the Paper. Mr. Stones replied in the affirmative, and added that at most works the same formula is worked to and holds good for bells from 100 lbs. to 100 tons in weight. A considerable amount of thought must have been required to work out this formula in such a way that it would be applicable to bells of all sizes.

Mr. Lion-Cachet wholeheartedly agreed with Mr. Stones that there are a great many people who do not know how to make bells. He recalled how he had once found a bell in a scrap-heap, and was thereby inspired to make a pattern and cast a small bell for summoning his children to dinner. He gave instructions for phosphor bronze to be used. Ultimately he decided to use the old bell because it sounded better. Mr. Lion-Cachet then asked Mr. Stones how bells were run and the risers attached.

Running Methods

Mr. Stones said that bells were run from the top. In the case of an ordinary house bell which had a lug on top to which a hook was attached, a riser was put on the top and cut off. Most big bells were run from the top, pouring being carried out downwards with a series of gates round the mould cavity.

In connection with heavy bells, Mr Lion-Cachet recalled a mechanical contrivance which he had seen. In the old days the mechanical operation of running gear was not satisfactory, and the difficulty of swinging a bell weighing several tons had to be overcome. This was done to some extent by using balance weights, but the trunnions increased the friction and the only lubricant available was animal fat. A special trunnion was therefore evolved. Mr. Lion-Cachet described one of these special trunnions, which consisted of an arrangement of plates giving a rolling friction at every point. Apparently this appliance had been running for a few hundred years but it was still quite satisfactory when he saw it.

In reply to Mr. Lion-Cachet, who asked whether many bells had been cast in South Africa and what were the results, Mr. Stones said that he knew of one bell only, which had been cast in his works to the design he had outlined, and was quite satisfactory. He was of opinion, however, that there might be a time when they might have to cast bells, and there were no bell founders in South Africa.

A Member asked whether the composition of the bell metal had any effect on the sounds. Mr. Stones in reply stated that eight bells of different sizes could be made with the same metal to give different sounds. By taking a chip out of the side a louder tone was imparted. The heavier the bell the lower the tone obtained.

What particularly impressed Mr. Holdsworth were the tremendous weights which had been cast, and he wondered how such weights of metal could have been poured. He presumed that all the metal had to be poured at once.

Mr. Stones said that all bells over 15 tons in weight were cast from metal melted in a reverberatory furnace, the metal being led direct from the furnace into the mould.

(*Continued from column one.*)

ously, thus enabling the casting to be delivered in a shorter time. The hole in the gauge stick is not square, but the diameter of the spindle long by half the diameter deep, thus fitting the spindle at the three crucial points, which is equally as accurate as a semi-circular hole. In Fig. 2 is a section and part-plan of the assembled mould for Fig. 1, the method of making being: A strong rectangular plate and two spindles are set up in correct relationship, the centres being tested by a double gap staff (Fig. 3). The bottom is prepared and the ends are swept by boards B and C, Fig. 4, and the pattern work D is used to form the intervening portion. As a part of the mould—A, Fig. 2—is above the pattern, this has to be removed to facilitate its extraction and the insertion of the core. This portion is carried on a suitable grid G and jointed back into the main structure. The core is made in one piece by boards E and F, Fig. 5. The method used is: On to a prepared bed, the ends are built on a grid H which embraces the two ends. The remainder of the core is built between two straight edges placed at tangents to the ends. Another large rectangular plate is used to carry a plain cope. After striking the mould, it is allowed to stiffen; the draw-back removed; the pattern portion removed; and the mould dried. The cope and core are also dried and assembly is commenced by levelling the mould in a suitable pit—which is subsequently filled in prior to casting to avoid a burst-out. The core is lowered in its correct position on thickness pieces of wood; the draw-back is returned to position and the cope lowered. The core and draw-back are then bolted to the top, which is lifted for the extraction of the thickness pieces, after which the whole is returned to position and made ready for casting.

Solidification of Aluminium Bronze*

By C. H. MEIGH

The duplex range of aluminium bronze alloys which are under consideration are illustrated in the form of a "micro-scale" in Figs. 1 and 2. At one extremity is shown an example in the alpha range, *i.e.*, almost entirely white—containing less than 7.5 per cent. aluminium—and at the other, an example in the beta range, almost entirely black—containing over 11 per cent. aluminium.

This method of presenting micro-structures in the form of a scale, simplifies the use of the microscope as a method of controlling the chemical composition of an alloy, or, the tensile properties of any given part of a casting without disfiguring the casting.

Fig. 2 represents a typical alloy in the duplex range containing 9.7 per cent. aluminium, 3 per cent. manganese, 3 per cent. iron and 3 per cent. nickel, cast in a sand mould, in thicknesses varying from 6 in. to $\frac{1}{8}$ in., and giving 7 different structures corresponding to different solidification speeds. Alloys containing nickel are becoming increasingly popular and Mr. Hudson's name is to be associated with their development. It will be noticed that, as the grain size decreases so the mechanical properties increase in value, from 35 tons per sq. in. in heavy sections, to 46 tons in thin scantlings, or sections that solidify rapidly.

The data shown in Fig. 2 were obtained from test-pieces cut from the different steps as shown in Fig. 3 and also from a block of metal 6 in. by 6 in. by 7½ in., which, in the form of a sand casting, may be considered as possessing minimum qualities which are unaffected by any further increase in mass.

In the casting, Fig. 3, each step has an influence on the solidification of the adjacent steps, for a certain distance, but test-pieces and etched specimens were taken from each thickness outside the affected zones. The figures given are averages of a number of tests, as any individual test may be falsified and, as it is not always an easy matter to visualise how metal solidifies in a profiled casting, a number of the stepped castings were moulded, so that the end of each step came to the top of the mould and solidification could be observed and timed.

The casting temperature was about 1,150 deg. C., the average time taken to fill the mould was 40 seconds, and the castings weighed 26 lbs. each. After the mould was full, the $\frac{7}{8}$-in., $\frac{3}{4}$-in., and $\frac{1}{2}$-in. steps solidified in 5, 14, and 32.5 seconds respectively, showing that solidification had taken place during the pouring period to the extent of 35/40 or 87 per cent. volume of the $\frac{7}{8}$-in. step; 65 per cent. volume of the $\frac{1}{2}$-in. step; and 20 per cent. volume of the $\frac{3}{4}$-in. step. Leaving the 1½-in. and 3-in. steps with the heart of the mass still molten—they solidified after periods of 78 and 210 seconds respectively. The expression "the heart of the mass" is used because solidification had started in layers parallel to the walls of the mould. With the object of obtaining comparative figures for the solidification speeds of a non-magnetic alloy containing 9.7 per cent. Al. 3 per cent. Mn, and the rest copper, and the complex alloy, previously mentioned, containing iron and nickel, other castings were run in, as far as possible, similar conditions.

In the non-magnetic alloy, the $\frac{7}{8}$-in. step solidified 15 secs. after the mould was full, as compared with 5 secs. for the nickel alloy. In terms of volume, 37.5 per cent. of the $\frac{7}{8}$-in. step in the non-magnetic alloy had solidified during the pouring, as compared with 87 per cent. of the nickel alloy, and, the other steps in the non-magnetic alloy were still molten at the heart, while the nickel alloy had solidified as previously mentioned.

The comparative behaviour of the two alloys is shown on Fig. 4. It is obvious that the pouring speed of the nickel alloy can be increased, to a certain extent, to compensate for its more

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. Barrington Hooper, C.B.E. presiding.

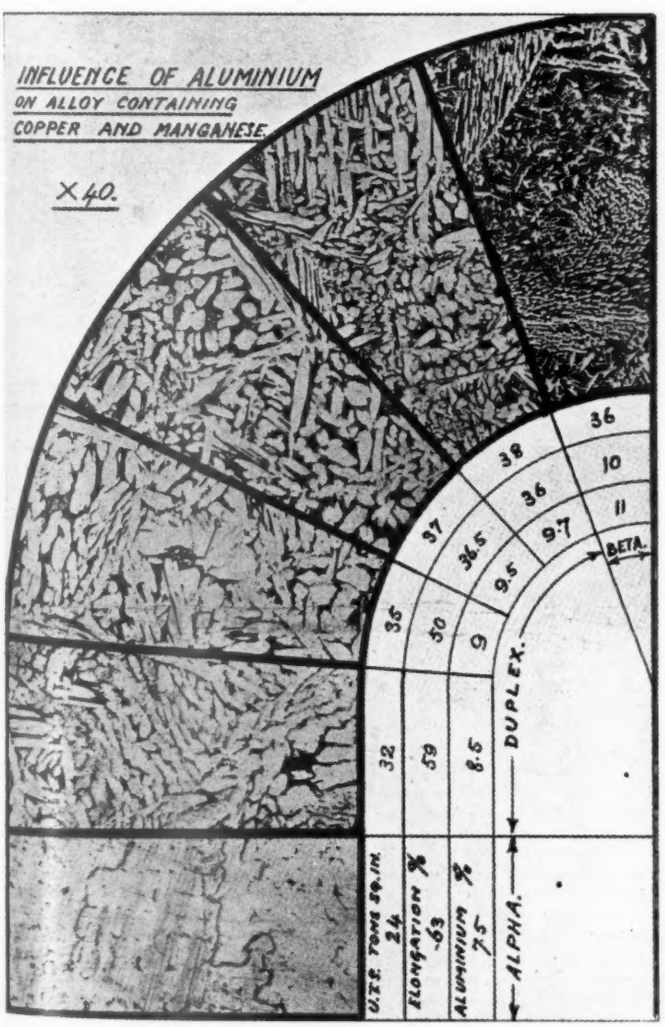


Fig. 1.—Influence of Aluminium on the Micro-Structure of an Alloy containing Copper and Manganese.

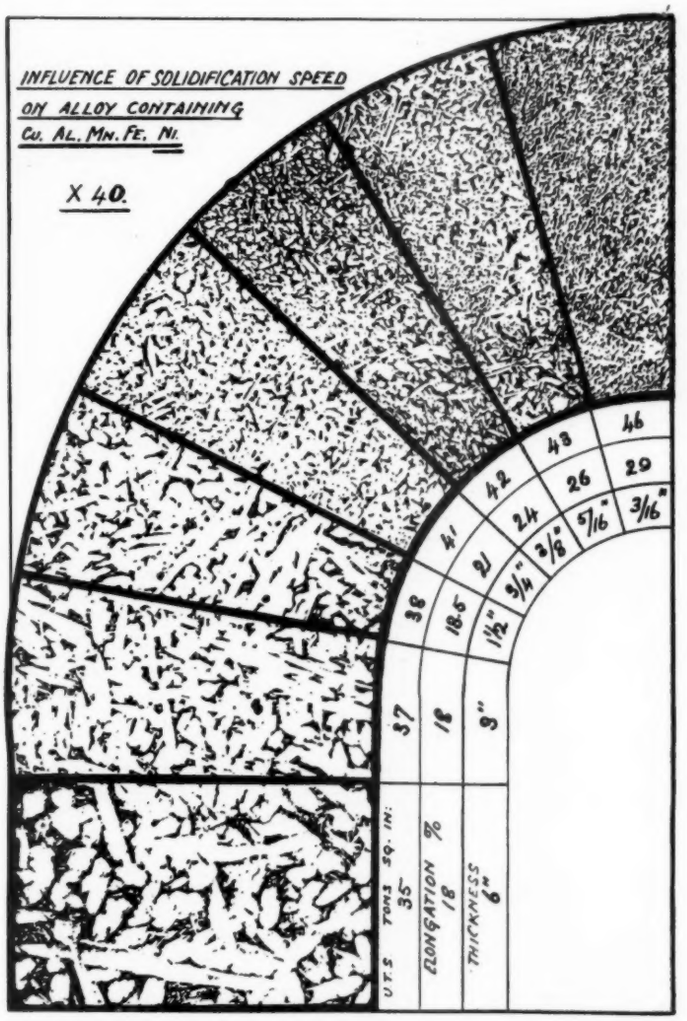


Fig. 2.—Influence of Solidification Speed on the Micro-Structure of a Copper-Aluminium-Manganese-Iron-Nickel Alloy.

rapid solidification, but there are limits of thickness and area, after which the nickel content must be cut down or eliminated, if moulds are to be filled under practical working conditions.

Thin sections solidify *in their entire thickness*, but the heavier sections solidify in layers approximately parallel to the mould walls and, as the total period of solidification in the 6-in. section takes 750 secs. for the nickel alloy, and 1,300 secs. for the non-magnetic, $\frac{1}{16}$ in. thickness of metal is solidified after 7.5 secs. in the former and 130 secs. in the latter; 1 in. thickness is solidified after a period of 116 secs. for the nickel alloy, and 227 secs. for the non-magnetic alloy. While, under average conditions, flow stops and piping starts after 395 secs. for the nickel alloy, and 645 secs. for the non-magnetic alloy, leaving a final solidification or feeding period of 360 secs. for the nickel alloy, and 645 secs. for the non-magnetic alloy.

Referring to Fig. 2, it is obvious that the speed of solidification, for any given thickness of section, can be influenced by a number of outside factors, and that the structure will vary accordingly, but a given structure has a definite ultimate tensile strength value. Micro-examination can therefore be used as a gauge of the tensile properties, rather than as an indication of thickness or speed of solidification in seconds, which are only given here to complete a picture.

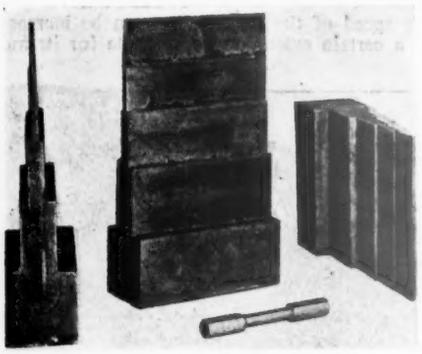


FIG. 3.—STEPPED CASTING FOR TESTING THE INFLUENCE OF THICKNESS ON MECHANICAL PROPERTIES.

The particle size of the constituents depends upon the composition of the alloy, the speed of solidification, the subsequent heat-treatment and the mechanical or physical treatment which the metal receives at different stages after solidification, but a given particle size represents a given tensile strength in a given alloy.

Whatever the composition of the alloy, the particle size is the greatest in the annealed state or in the "as-cast" state, in the case of heavy masses. There are several ways of obtaining a given structure, but it is proposed to limit this discussion to the modifications of structure brought about by different solidification speeds.

Speed of solidification, and heat-treatment after solidification, have as much influence as mechanical treatment on the micro-structure, and hence on the physical and mechanical properties of aluminium bronze. Such technical information as has hitherto been published on the subject of solidification speed gives the impression that there are only two possibilities, namely, those arising from sand and from chill casting, and that the latter must essentially be restricted to the relatively few castings that can be cast in a metallic mould. This impression is entirely erroneous, and the data given on the scales show how qualities may be varied in a sand casting, and how this variation depends upon mass, and has nothing to do with the use of chill moulds.

These data also show the fallacy of relying too much on results obtained from standard test-pieces no matter whether they are cast-on or separately. Such test-pieces give valuable indications as to the quality of the metal from the furnace, but not in the casting.

Design

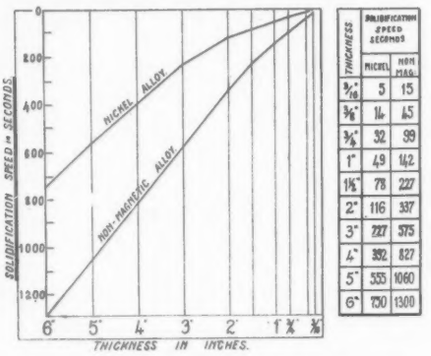
The characteristics given in Fig. 2 show, that although exceptionally good properties are obtained in thick sections, they are improved in every respect, as sections are reduced and solidification is correspondingly accelerated.

Perfectly satisfactory aluminium bronze castings can be made from patterns intended for other metals. The fullest advantage, however, can only be taken of the properties of these alloys by specialised design, reducing thicknesses where it is desirable to do so, and thus effecting the maximum economy, not only in the intrinsic value of the metal employed, but also in moulding cost.

It is obvious that an appropriately lightened design, whilst affording these economies will, at the same time, offer a degree of security equal to one in which thick and heavy sections are employed, more by force of habit than from a stand point of practical utility.

Aluminium copper alloys pass almost instantaneously from the liquid to the solid state, and in doing so the metal is reduced to 9/10ths of its liquid volume before the commencement of ordinary lineal contraction.

These conditions of solidification offer very



THICKNESS	SOLIDIFICATION SPEED SECONDS	
	NICKEL	NON MAG.
1/16"	5	15
3/16"	14	45
3/8"	32	99
1"	49	142
1⅛"	78	227
2"	116	337
3"	227	575
4"	392	827
5"	555	1060
6"	750	1300

FIG. 4.—SOLIDIFICATION SPEEDS TO BE ASSOCIATED WITH INCREASING METAL SECTION.

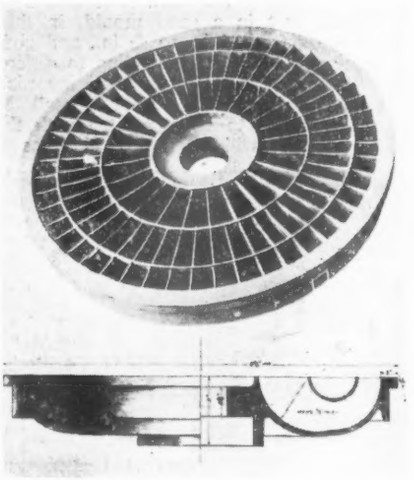
considerable advantage over those of alloys which pass through a "pasty" phase prior to complete solidification. At the same time they necessitate special treatment during the casting operation, to ensure that an adequate supply of metal is provided, to replenish what would otherwise be empty space caused by reduction in volume. This reduction in volume may be termed "internal contraction" as opposed to shrinkage or surface contraction.

Fig. 5 shows a casting consisting of a heavy boss 4½ in. thick, and a heavy outer flange and ring 1⅛ in. thick, united by light webs, ⅜ in. thick. It affords a good illustration of the advantages of single-phase solidification. In the commoner bronzes the webs solidify and begin to shrink while the boss, and outer flange, are still in a more or less pasty condition.

Fractures are thus caused in the paste, which has neither strength nor ductility. In aluminium copper alloys, the webs solidify and act as cooling fins, thereby accelerating solidification in those parts of the molten masses in their immediate vicinity. As soon as the metal solidifies, it possesses both strength and ductility, and the lineal contraction, which is normally 1.8 per cent. and which would otherwise set up internal stresses, is compensated either by the sand being crushed or by the elongation or deformation of the metal up to a maximum of 1.8 per cent., whilst it is still at a temperature within the annealing range.

If the moulding material has a uniform coefficient of conductivity, a casting of uniform thickness solidifies in layers parallel to the mould face.

Fig. 7 represents a flywheel with a heavy rim and boss, and with spokes of different design, and shows the order of solidification. Where a thin section joins on to a thick section, *i.e.*, the rim and boss, it accelerates solidification at a place near its point of contact I and J, whilst in section H, of much greater thickness, there is the reverse effect. If the rim and boss were cast separately, solidification would occur in layers of uniform thickness, A, C and D representing the layer solidified after the first period, and B that after the second period. Total solidification might occupy 30 min. If the other sections, E, F, G and H, are cast with the rim and boss, solidification of both the latter is modified according to the respective heat-absorbing effects of the arms. The section E is, say, ¾ in. thick, and solidifies in, say, 170 secs., and, while part of its lineal contraction is taking place, it cools the metal in the rim and



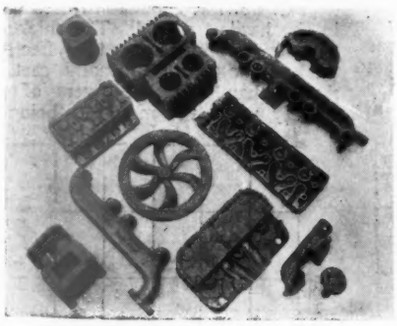
FIGS. 5 AND 6.—PRIMARY WHEEL FOR HYDRAULIC CLUTCH WEIGHING AS CAST 2,366 LBS. (COURTESY, BARCLAY, CURLE & COMPANY, LIMITED.)

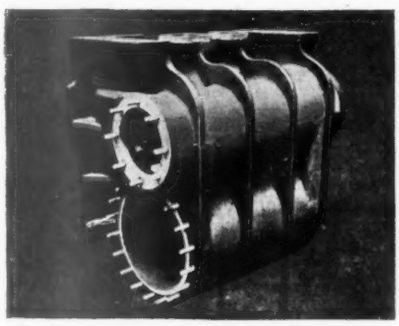
boss, I and J. At the same time, the general fall in temperature is producing solidification layers, A, C and D.

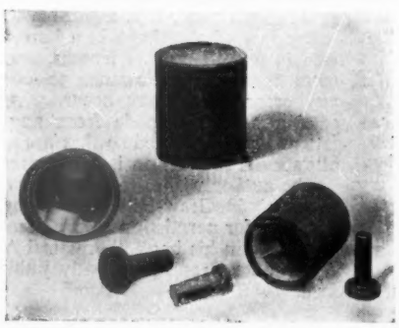
During the second period of, say, 15 min., the area shown as grey becomes solidified, and has fed the metal previously frozen. Solidification will then progress, and the last places to freeze will be L, M and N respectively. These places in turn will be fed by suitable headers, and a perfectly sound casting will be produced without the use of artificial chills. The tensile properties of each part of the casting will vary according to the speed of solidification, but neither weak places nor internal stresses will exist.

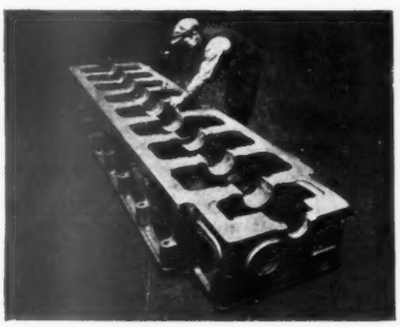
When radii are used for spoke F, the chilling effect on the masses is slightly reduced. This effect is still further reduced by the addition of necks and radii, as in spoke G. By increasing the section as at K, the mass of the rim is increased, and solidification is retarded, as shown by the black area.

It will be noticed that the use of radii or necks for joining thin to thick section is of no disadvantage. This is not the case, however, when two thin sections are joined together as is shown in Fig. 8, which illustrates suitable, and unsuitable methods. In this illustration P represents the wall of a chamber; and the metal in the walls of even thickness solidify in, say, 30 seconds, for the junctions Q and R have no retarding effect on solidification. If, however, radii are used as at S and T, solidifi-









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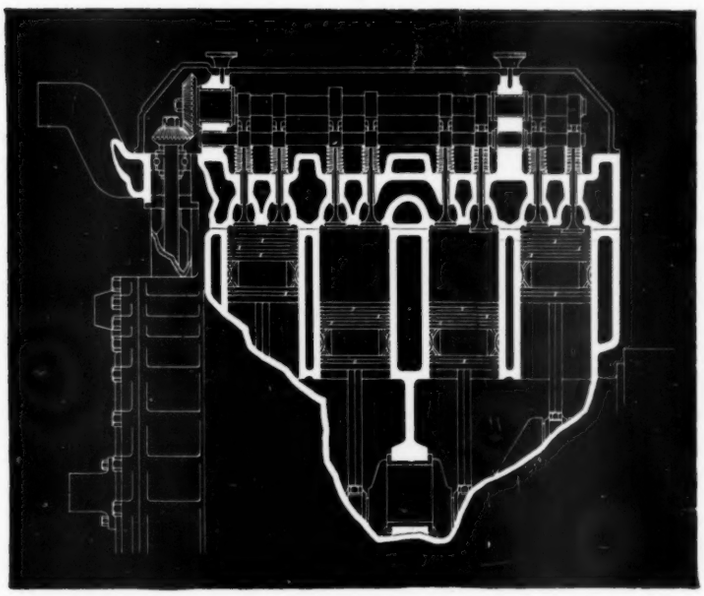

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cation takes much longer at the junctions, and as there is usually no possibility of providing a supply of feeding metal, cavities or porous zones are formed, which weaken the casting, at places where extra strength was expected by the designer. This effect may be overcome by the use of artificial chills, but the operation is costly. Moreover, it is unnecessary, if the designer appreciates the difference between the single-phase solidification of aluminium copper alloys, and the dual-phase solidification of those alloys of lower tensile strength, that are in more general use.

Use of Chills

Chills are used in the foundry either to ensure sound castings or to produce local increase of tensile strength in vital parts. Their use is costly and should be avoided whenever possible. Much may be done in this direction by designing to ensure the maximum uniformity of thickness throughout a casting. When a local increase of thickness is required, such

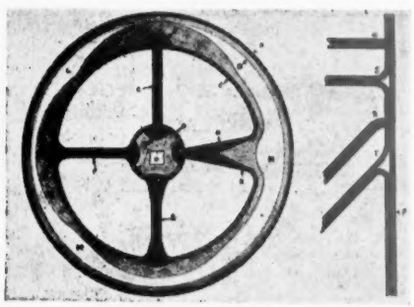

Fig. 7 (Left)—Flywheel showing Order of Solidification; and Fig. 8 (Right) showing Use of Radii in Design.

places should be situated where they can be attached by feeder heads, or else they must be chilled.

It must be remembered that the machining allowances result in increases of mass, and that although a casting may be designed with uniform thickness, the thickness "as cast" may vary considerably. These remarks apply to such castings as valve seats, but the thickening up of flanges, for machining, presents no difficulty—the flanges being easily fed or chilled, while the chilling of the valve seats would be at least a costly operation, and in some cases extremely difficult.

There is a limit to the effect of chills, usually dependent on the proportion of the surface of the mass that can be covered by them. To illustrate this point Fig. 9 shows the comparative effects, produced on different thicknesses, by full chill, semi-chill and sand casting. For example, a cube of the alloy with 8-in. faces chilled on five sides will solidify at the same speed as one with 7-in. faces chilled on one side, or as a 6-in. cube cast in sand without chills. In thinner sections for instance, a 3-in. thickness in the form of a plate chilled on both sides, would solidify at the same speed as a 2-in. thickness chilled on one side, or $\frac{5}{8}$-in. thickness without chills, or a 2-in. thickness chilled on both sides would solidify at the same speed as $1\frac{1}{4}$-in. thickness chilled on one side or $\frac{3}{8}$-in. thickness without chill.

Such figures as these must be regarded as only approximate, since they are influenced by a number of outside factors. They indicate, however, the limits within which sound castings can be produced in spite of inappropriate design, or alternatively, the extent to which vital parts of castings can be given increased tensile strength.

By reference to an appropriate micro-scale, such as Fig. 2, and the corresponding graph, it is easy to determine, in advance, properties which may be given to the different parts of the casting, by taking into consideration the thickness of the metal and possibility of using chills.

Chilling in the mould, though beneficial when used in the manner described, should be followed by a stress-relieving treatment, to eliminate internal stresses. Such stress-relieving occurs automatically under ordinary conditions of cooling in a sand mould.

Shrinkage

The shrinkage of aluminium bronze depends to a great extent on the method of pouring, the speed at which the mould is filled and the thickness of the casting. The maximum shrinkage of these alloys is 2.4 per cent., but the conditions under which such a high figure is reached are extremely rare. They occur, in fact, only in the case of such castings as bars, which are cast very rapidly and are free to contract without hindrance.

In profiled castings of all kinds there are

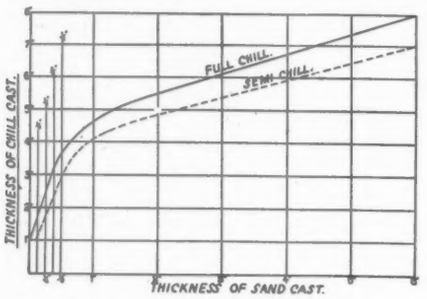

Fig. 9.—Relationship in Mechanical Properties of Chill and Sand Castings.

various influences which have their effect upon shrinkages. These are as follow:—

(1) Slow pouring allows the metal to solidify, and to start shrinking while the mould is actually being filled, thus reducing the amount of shrinkage in the finished casting. It has the greatest effect in the vertical direction in which a casting is being run, where it reduces contraction to about half that in other directions.

Table I.—*Solidification Conditions in Different Thicknesses*

Percentage volume solidified during pouring.	Thickness in inches.	Speed in seconds.		Percentage volume solidified during pouring.
		Nickel alloy.	Non-magnetic	
87	$\frac{3}{16}$	5.0	15	37.5
65	$\frac{3}{8}$	14.2	45	Molten.
20	$\frac{3}{4}$	32.5	99	,,
Molten	1	49.5	142	,,
,,	$1\frac{1}{2}$	78.0	227	,,
,,	2	116.0	337	,,
,,	3	227.0	575	,,
,,	4	392.0	827	,,
,,	5	555.0	1,060	,,
,,	6	750.0	1,300	,,

Layers of Solidification in 6-in. Cube.

Alloy.	Percentage volume solidified.	Time in seconds.	Thickness in inches.
Nickel	73.0	555.0	Piping.
,,	52.5	392.0	,,
,,	30.5	227.0	2.1
,,	15.5	116.0	0.95
,,	10.5	78.0	0.63
,,	1.0	7.5	0.06
Non-magnetic	82.0	1,060.0	Piping.
,,	64.0	827.0	,,
,,	49.5	645.0	,,
,,	44.0	576.0	2.55
,,	26.0	337.0	1.56
,,	17.5	227.0	1.05
,,	11.0	142.0	0.66
,,	1.0	130.0	0.06

Take, for example, the stepped casting already mentioned in which 87 per cent. volume of the $\frac{3}{16}$ in. step: 65 per cent. of the $\frac{3}{8}$ in. and 20 per cent. of the $\frac{3}{4}$ in. step solidified during the pouring period.

(2) The extreme plasticity of these alloys, just below their melting point, allows them to "give" when resistance is encountered from a core, or projection on the moud, which again results in reduced shrinkage in the casting. This plasticity produces its greatest effect in very thin sections, which are not strong enough to crush the sand. There is seldom any measureable contraction in the walls of a casting $\frac{3}{16}$ in. thick.

(3) The high degree of tensile strength which the metal possesses at temperatures of from 700 deg. C. downwards enables it to crush the sand in the hardest mould. The thicker the casting the more pronounced is this effect, as, although thick sections are normally cast much more slowly than thin, the layers of metal which solidify while the mould is being filled attain

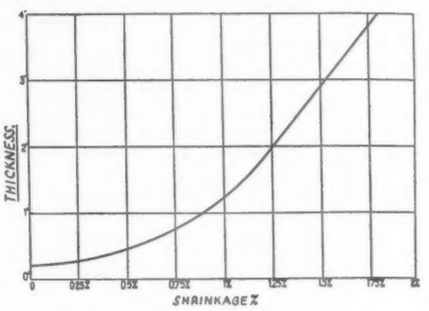

Fig. 10.—Shrinkage in Castings of Different Sections.

sufficient strength to crush the sand before filling is completed. This tends to increase shrinkage of the finished casting.

Whilst these influences make it impossible to formulate definite rules for the estimation of shrinkage, the figures given in Fig. 10 may be taken as a general guide.

In cases where accuracy of dimensions is of great importance, it is advisable to allow for a lower rate of shrinkage in a bore, and a higher rate in overall outside lengths, and to leave an extra machining allowance to compensate for any error which may occur. After the first casting has been made from any pattern, the latter may be rectified so that normal machining allowances are left on it for future use.

The author wishes to express his indebtedness to the McGraw-Hill Publishing Company, Limited, for permission to use some of the data appearing in his book, "Practical Application of Aluminium Bronze," recently published by this firm.

Central Compressed-Air Supply at Steelworks

Analysing the comparative merits, as regards efficiency and economy, of compressed air and steam at steelworks for the operation of hammer plant and small pneumatic tools, W. Garski, in Report No. 87 of the machinery sub-committee of the Verein deutscher Eisenhüttenleute, published in a recent issue of "Stahl und Eisen," points out that the ratio of the thermal efficiency of a compressed-air system to that of a steam plant used for the same purpose is about 18:8, without considering the losses due to bleeding or leaks, which would increase the ratio still more in favour of compressed air. The economic superiority of compressed air over steam is not so large and depends entirely on the costs of generation, which in large plants justify the installation of a central compressing plant with distributing mains to all points of consumption. In 1933 the Bochumer Verein decided to introduce a centralised system of this type at their works. Details of this plant and the experience gained with it from 1934 onward are covered in the report.

Planning the Third Metal Age

INVITATION TO DESIGNERS

We have invited a number of experts in design to set down their ideas about the Third Metal Age. We realised that they would have a different approach to the possibilities of Aluminium and its Alloys from the technical expert ; but we felt that their ideas would be interesting and stimulating. We said to each of these designers : " The Bronze Age and the Iron Age are behind us, and we are now in the age of Aluminium and its Alloys. Although war-time conditions have put temporary restrictions on supplies, Aluminium is the inevitable material for every branch of industry. There are inexhaustible supplies of the raw materials for it.

" Now, how do you react to the possibilities of this Third Metal Age ? You are interested in the form and function of all kinds of things. Here is a brief summary of the qualities of Aluminium and its Alloys :

High strength to weight ratio. Ductility. Ease and economy of casting and fabrication. High thermal and electrical conductivity. High reflectivity for light and heat. Low specific gravity. Resistance to corrosion. Freedom from rusting. Wide range of finishes and colours.

What particular problem of design do you think would be solved with a material that has all these remarkable properties ? "

Here we show how one of these designers, Mr. Christian Barman, F.R.I.B.A., has answered our invitation.

NOTES ON ALUMINIUM FOR HEATING

By Christian Barman, F.R.I.B.A.

I HAVE heard it asserted that the time is not far distant when aluminium will be used as widely in the heating of buildings as it is to-day in the construction of aeroplanes and vehicles. I believe the judgment behind that statement is sound. The statement, you see, is based on facts. Not only one or two properties peculiar to aluminium point to the inevitability of such a development, but a whole sequence of properties. Here are some that have struck me most. (In every case, the name of the metal is used to include its various alloys.)

1 Aluminium is an efficient conductor of heat. It will conduct heat at approximately three times the rate of, for example, iron or steel.

2 And yet, because of its high reflectivity, aluminium is a first-rate heat insulator. In foil form, it is already widely used for this purpose.

3 Aluminium with a simple and natural surface finish, becomes one of the very best heat radiating surfaces known to science.

4 Aluminium is light. This, one of its most familiar properties, is especially valuable in all portable or semi-portable appliances and parts.

5 Aluminium requires no surface maintenance. Its natural finishes are permanent. There are no upkeep costs.

6 Aluminium is beautiful to look at. There are a wide variety of simple surface treatments whose artistic possibilities are boundless.

7 Aluminium is clean. Should any corrosion take place, the products of corrosion are colourless. Aluminium cannot cause staining or discoloration of wall or other surfaces.

8 Aluminium is hygienic. Neither the metal nor its compounds are retained by the digestive organs of man. Any kind of poisoning is, therefore, impossible.

9 Aluminium is easily worked. It is already being fabricated in every form in which it would be required in a modern heating installation. It is cast, extruded into sections, drawn into tubes, machined and forged and welded ; all with great ease.

Take all these points together. Consider the high thermal performance of aluminium, and add to that its economy of upkeep, its cleanliness, its good looks.

DESIGN FOR AN ELECTRIC FIRE IN ALUMINIUM Scale 1″ to a foot

ELEVATION : The basket is built up from vertical rings of heavy gauge aluminium wire and horizontal rings, flat sections cut from sheet metal. The heat element is a rod placed vertically in the centre of the basket. The polished aluminium reflector is concave in the middle, convex at the sides. The rods and flat rings are of anodised aluminium of contrasting colours. The ring-shaped handle at the top is of plastic. The base of the fire has three feet, and the bottom is slightly weighted to give extra stability. But the fire is just as safe if it should be thrown over on its side.

In this portable electric fire, aluminium comes into its own in many ways. It is a radiant fire. Aluminium will reflect up to 85 per cent. of average radiation.

There is secondary heating by convection. The fins at the back of the cast aluminium reflector quickly reach a high temperature.

This portable fire, including the length of aluminium flex, weighs only a few ounces.

This fire, in its spherical basket-guard, can be upset and rolled about without danger. The bars of the aluminium basket are finished in a semi-matt peach colour, the rods of brilliant silver slightly darkened to grey. Only aluminium can give finishes like these.

The heat beam from the reflector has a wide lateral spread. In the vertical plane the beam is more highly concentrated. The air in the room is heated by an arrangement of convector fins.

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THE LARGEST DISTRIBUTORS IN THE BRITISH EMPIRE OF ALUMINIUM AND ITS ALLOYS IN ALL COMMERCIAL FORMS · THE ADELPHI, STRAND, LONDON, W.C.2, AND AT SHANGHAI AND OSAKA

Foundry Sand Research

In order to maintain the correlation of work done on foundry sands in the United States and in this country, we have extracted below some sections of a Report made by Dr. H. Ries, of Ithaca, who is Technical Director of Foundry Sand Research Committee of the American Foundrymen's Association.

Green Deformation

It is doubtful whether green deformation is given as much attention by foundrymen as it deserves; indeed, a rather wide difference of opinion is expressed by different ones regarding the importance of such a test. Attention was called to this property in a Paper by Dietert,[1] in 1936, in which some of the practical bearings of the green deformation test are shown.

As said by some, the manner of using the sand may have a great deal of bearing on the value of the green deformation test. In view of the fact that some foundrymen have doubts regarding the value of this test, it may be well to give the opinions of several who use it extensively.

One writes, green deformation ". . . is directly related to the ability of sand to resist a tendency to crush under load. It is a property of the sand which encourages or prevents crushes in foundry practice. Crushes may be due to improper pattern equipment, improper manufacture of pattern itself or manipulation of operator in placing cope on drag. In latter case, if cope does not come down horizontally, or flask pins are loose, it is very apt to cause a crush unless sand is able to deform sufficiently."

Cope drops and broken edges of moulds, when drawing patterns, may be due to sand being too brittle, even though having sufficient green compressive strength. Green deformation should show the trouble.

Another operator writes: "Deformation shows 'liveliness' or 'deadness' of a facing. A sand mix with dead feel may test satisfactorily for green compression and moisture, and yet be unfit for foundry use. If mulled longer, it may gain life and deformation rise proportionately. If, on the other hand, the mixture is mulled too long, it may ball up in the mill and deformation rise too high. Hence, deformation may serve as a check on the sand as well as the efficiency of the mill operator."

It is stated by one operator that: "Low deformation has caused us to experience the following:—(1) Rough mould surface consequent upon stripping; (2) mould surface erodes easily when cleaning with compressed air; (3) mould hard to finish, making moulders complain of poor quality facing; (4) after air-drying, sand grains slough off, leaving a very weak sand and causing dirty castings; and (5) mould has strong tendency to crush on closing."

"With deformation values high, the sand rams with difficulty and a low mould hardness is experienced in spots, causing swells on the castings."

"If moisture be constant and compressive strength increases while green deformation decreases, it may be an indication that mill operator has added bond to get the proper feel."

As illustrative of the bearing of green deformation on the behaviour of sand, the following test data on the same sand obtained on two different days may be quoted.

	Moisture.	Green lb. per sq. in.	Green shear lb. per sq. in.	Green perm.	Mould hardness.	Deformation, in.
1	4.1	8.1	2.5	150	76	0.015
2	4.2	7.3	2.4	150	72	0.030

Disregarding green deformation, No. 1 would seem to be superior, but, if used, would show excessive sloughing off, and washing during pouring. Castings from No. 1 would be dirty and from No. 2 clean. It would seem as if the difference in green deformation is the cause.

Tensile Strength

It appears that this test is not used as often as the green compression test, although some foundries specify it. Others use both tensile strength and green compression in laboratory tests. Some foundrymen believe that it gives no information not given by the green compression test. One opinion expressed is that in brittle sands, the tensile strength is relatively lower than green compression.

Some believe that the green tensile strength test is more important for checking trouble in plate or brass sands of 180 or greater average fineness. It is thought in this connection that the tensile strength of fine sands gives a more accurate indication of active clay content than does the compression strength, as the "fines" in the sand create more compression than tensile strength. Furthermore, the tensile strength decreases more rapidly than the compression strength as the sand successively burns out.

General Comments on Strength Tests

The compression strength test is the most widely used, and usually appears to give sufficient information. Unless there is some special reason, additional kinds of strength tests are not necessary. The Committee on Standard Tests has no intention of recommending that all these tests should be made on the same sand, but has prescribed a standard method for making each one of these strength tests where it seems desirable to use them.

Troubles Caused by Improper Technique

Ramming.—There is no more widely used step in clay testing than the preparation of the standard specimen by ramming, and the Foundry Sand Research Committee has made every effort to get this standardised. In the handbook of testing attention was called to the fact that the character of the support has some influence on the test results, and in the A.F.A. Transactions[2] a number of figures were given to emphasise this point. Nevertheless, it has been found that there is some laxity in this matter. For this reason, attention is again called to the fact that the rammer base should rest on and be fastened to a firm non-yielding support.

It is found, for example, that if the rammer base is bolted to a concrete base, a solid wood timber support or a thick heavy iron plate, the best results will be obtained. A yielding support means less intense ramming and the same sand will, under such conditions, show higher permeability and lower compression-strength figures.

Specimen Tubes.—Care should be given to specimen tubes to see that the inner surface is kept perfectly smooth, otherwise variation in results of strength tests are likely to occur.

Clay Separation.—The viscosity of water decreases with a rise in temperature. Consequently, particles of a given size may settle more rapidly in warmer water. Therefore, two clay determinations might not agree if made with water of different temperatures. This may account for some of the discrepancies that are sometimes noticed when comparing the results of two different operators.

Sintering Test.—Although the Committee several years ago suggested a sintering test and attempted to recommend a method for making the same, there has been a lack of uniformity in interpreting the results obtained, and a new sub-committee is now at work attempting to improve the technique of the test.

Core Hardness.—The sub-committee appointed to recommend a method for determining this property suggests the use of a hard metal plough which protrudes through a slot in a plate. This plate is drawn across the surface of the core, and the projecting plough causes a scratch whose depth depends on the hardness of the core. The plough is spring loaded, and can be connected with a dial indicator which shows the depth of penetration.

Durability and Flowability are two properties for which no test has yet been recommended by the Committee. Both represent important problems not yet satisfactorily solved. Sub-committees have been appointed to study them.

Definitions.—With the development of high-temperature tests, it has become necessary to formulate terms to be used in referring to the properties and behaviour of sands when heated. Certain terms now in the glossary of the Handbook of Testing have also been clarified. The sub-committee appointed for this purpose has presented a report, which is shown in the 1940 Bound Volume "Transactions."

Tests of Steel Sands at High Temperatures.—Following last year's Convention, there was issued a progress report by Sub-Committee 6*b*7, outlining the work that had been done on the mixtures specified by it. Since the publication of this report, some further work was done on cereal-bentonite mixtures. G. W. Ehrhart, graduate student in Mechanical Engineering, Cornell University, Ithaca, N.Y., has been carrying on some interesting tests on the expansion at high temperatures of the mixtures previously tested. He also has developed a furnace for correctly and accurately determining the expansion of sands at high temperatures.

The sub-committee has approved a programme for further work in which more effort will be made to determine the effect of individual constituents of steel-sand mixture.

Future Problems.—There is still much to be done in the study of moulding sands. The Committee has recognised certain properties, and it has set up methods whereby most of these properties can be tested. Others are in preparation. There is still much work to do in determining the causes of the differences in behaviour of different sands and mixtures. It is also possible that there is a relationship between certain properties not hitherto suspected. To get at the solution of these problems calls for much painstaking work, involving the study of numerous mixtures under varying conditions. Work of this sort undertaken to determine the effect of different constituents and different conditions should be so carried out that investigators have at first to deal with only one variable, and work from simple to more complex conditions.

REFERENCES.

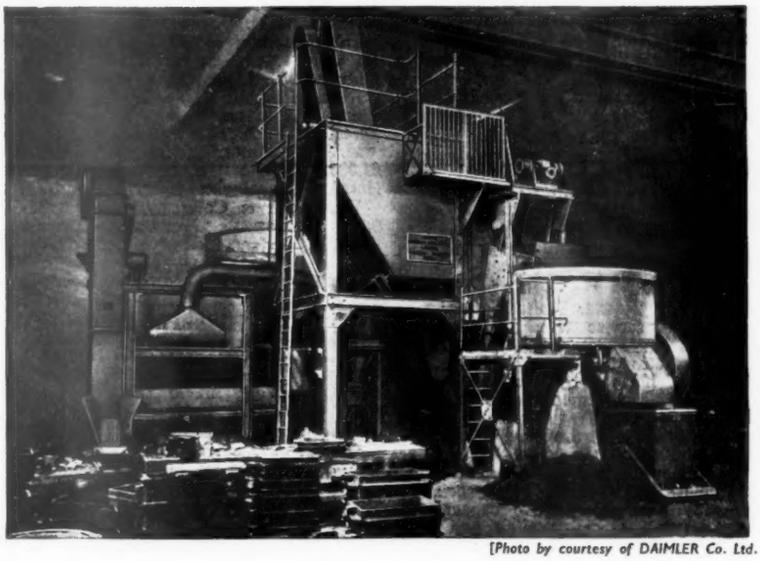
[1] Dietert, H. W. and Dietert, R. A., "Deformation and Resilience of Moulding Sand," American Foundrymen's Association Transactions, vol. 44, p. 139, 1936.

[2] Report of Committee on Sand Tests, Transactions, American Foundrymen's Association, vol. 35, p. 182, 1927.

Activity of U.S. Steel Industry

In the past 264 months, *i.e.*, from 1919 to the end of 1940, the United States steel industry has operated at between 70 and 100 per cent. of capacity 41 per cent. of the time, between 50 and 70 per cent. of capacity 29 per cent. of the time, and at and below 50 per cent. of capacity 30 per cent. of the time, according to periodical returns of the American Iron and Steel Institute. During the past 22 years the average of the utilisation of existing capacity has been only 61 per cent., and the industry could have produced 404 million tons more than it did if it had operated consistently at an 85 per cent. production rate. From 1936 to 1940 inclusive, if the production rate had been 85 per cent. of capacity, the United States steel industry could have produced 81 million tons more than it did.

SAND PREPARATION AND RECONDITIONING



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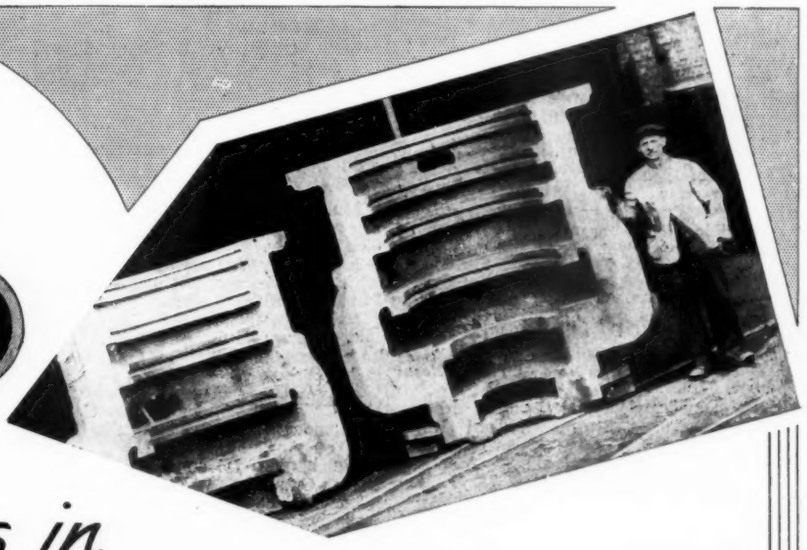

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The Week's News in Brief

Trade Talk

THE IRONFOUNDERS' NATIONAL CONFEDERATION has changed its address from Caxton House, S.W.1, to 100, St. Ermin's, Westminster, S.W.1. The telephone number is Whitehall 3176 (extension 209).

THE ANNUAL GENERAL MEETING and election of officers of the West Riding of Yorkshire Branch of the Institute of British Foundrymen will be held at the Technical College, Bradford, on Saturday next, at 6.30 p.m.

DISTRIBUTION OF STEEL SUPPLIES—The authorities ask us to state that applications for steel referred to in the paragraph beginning "(3) The production . . ." and ending "and iridium" in column 3, page 272, should be sent to the Ministry of Supply, R.M.1C, The Castle, Warwick, and not to the Non-Ferrous Metals Control as previously stated.

THE INSTITUTION OF CHEMICAL ENGINEERS and the Chemical Engineering Group are holding a joint meeting on May 13 at 2.30 p.m. in the Rooms of the Geological Society, Burlington House, Piccadilly, London, W.1, when a Paper on "Economical Raising of Steam in Small and Medium-Size Boiler Plants" will be presented by Dr. G. W. Himus, Ph.D.

AN EXTENSION to Wallsend Hospital, to be known as the Sir G. B. Hunter Memorial Hospital, has been completed, and officially opened by Lady Greig, daughter of Sir George and Lady Hunter. Sir George gave the building for the original hospital. The directors of Swan, Hunter & Wigham Richardson, Limited, and of the Wallsend Slipway & Engineering Company, Limited, defrayed the cost of the extension.

MR. OLIVER LYTTELTON, President of the Board of Trade, speaking at Sheffield on the methods by which concentration of production could be achieved, emphasised that it was not the Government's wish that large firms should absorb small firms or that necessarily financial amalgamations should take place. They would prefer to see groups of small firms make their own arrangements. The Board of Trade would indicate to the various industries what the degree of concentration should be and where the demand for labour for munitions was likely to be heaviest and where lightest. Individual firms would be asked to make arrangements for concentration among themselves. If conditions laid down were fulfilled, the firm would get a Board of Trade certificate that it had become a protected firm. If no commercial arrangements were from the nature of the particular industry possible, there was a wide range of financial arrangements which would still make concentration possible.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"MUREX"—Oxy-acetylene welding rods. MUREX WELDING PROCESSES, LIMITED, Hertford Road, Waltham Cross, Herts.

"MALLORY"—Common metal alloys. MALLORY METALLURGICAL PRODUCTS, LIMITED, 78, Hatton Garden, London, E.C.1.

"TOMMY'S COOKER"—Stoves burning solidified fuel. TOMMY'S COOKER COMPANY, 16, Melon Road, Peckham, London, S.E.15.

"HIDUMINIUM"—Electrical apparatus, hand tools, etc. HIGH DUTY ALLOYS, LIMITED, 89, Buckingham Avenue, Trading Estate, Slough, Bucks.

Improved Illumination for Steel-Billets Inspection

To enable night-time inspection of steel billets to be carried on for the first time, 96 Westinghouse "millite" lamp units have been installed in the chipping room of a large American steelworks to raise the light levels from 10 to 60 foot-candles. Proper illumination is essential to billet inspection. The outer crusted surface of the steel is chipped off, exposing the raw inner metal to the eyes of the men whose job it is to detect flaws in the metal structure. Installed at 12 by 12-ft. spacings, and mounted 40 ft. above the floor of the room, each unit uses a 1,000-watt incandescent lamp, says "Steel."

Personal

MR. J. M. BOYLE has been elected a director of Engineering Components, Limited.

MR. H. E. PERCY BEARD has been elected a director of the Neepsend Steel & Tool Corporation, Limited, in succession to the late Mr. W. F. W. Marshall.

MR. K. E. GREIG has been appointed managing director of Scotts' Shipbuilding & Engineering Company, Limited, and Mr. D. M. P. Phillips has been appointed a director of the company.

MR. WILLIAM MCFARLANE, manager of Ross Colliery, Ferniegair, Hamilton, belonging to Archibald Russell, Limited, for 17 years, has been appointed manager of the Whitehill Wagon Works, Hamilton.

BRITISH INSULATED CABLES, LIMITED, announce that, after 46 years' service with the company, Mr. E. A. Bayles retired from the position of works manager at Helsby on March 31, 1941. At a large gathering of his colleagues a presentation was made, prior to his retirement, when the joint managing director, Mr. W. Travis, referred to his invaluable contributions to the development of rubber cable manufacture, in which sphere his name was pre-eminent throughout the entire industry. Mr. Bayles is to retain his association with the company in a consultative capacity in technical matters. Mr. G. H. Walton has been appointed works manager at Helsby as from April 1 last.

Wills

PERKS, J. H., of Wollescote, Stourbridge, formerly works manager of John Perks & Son, forgers, Lye ...	£2,235
MACKENZIE, L. P., ironfounder, of Mackenzie & Moncur, Limited, Edinburgh	£34,754
CARPENTER, SIR HENRY C. H., past-president of the Institute of Metals, the Iron and Steel Institute and the Institution of Mining and Metallurgy	£36,943
SPARKS, C. P., of Worthing, Sussex, formerly of Dorking, Surrey, vice-president of the British Electrical and Allied Manufacturers' Association	£42,169

Obituary

MR. JAMES HUGILL, proprietor of the Hugill Forge & Engineering Works, Thornaby-on-Tees, died recently.

MR. DAVID WILLIAM MACDONALD, for many years with the Tharsis Sulphur & Copper Company, Limited, died at Rothesay on April 14.

MR. WILLIAM GORDON LIVINGSTONE, late assistant secretary of the Iron Trades Employers' Insurance Association, Limited, Glasgow, died last week, in his 69th year.

MR. WILLIAM HAYDN HAVENHAND, for over 60 years with W. A. Tyzack & Company, Limited, steel manufacturers, etc., Stella Works, Sheffield, died on April 11, aged 81.

WE REGRET to announce the death of Capt. R. B. Crewdson, whilst on duty as an air-raid warden. Capt. Crewdson was for a few years joint managing director of THE FOUNDRY TRADE JOURNAL.

THE DEATH of Lord and Lady Stamp came as a profound shock to British industry. Lord Stamp was president of the London Midland & Scottish Railway, a director of the Bank of England and a noted authority on economics.

SIR CHARLES FIELDING, formerly chairman of the Rio Tinto Company, Limited, died at Ingfield Manor, Billingshurst, on April 9, aged 77. During the last war the Rio Tinto Company supplied the Allies with pyrites at pre-1914 prices. In 1917 he was chairman of the Economy of Metals and Materials Committee of the Ministry of Munitions and he also served on the Council of the Ministry of Reconstruction, as a member of the Non-Ferrous Metals Committee of the Board of Trade, as a member of the Government Restriction of Imports Committee, and on Lord Milner's Committee on the Production of Food in 1915. In 1906 he had been a member of the committee which established the College of Science of Technology. He was created K.B.E. in 1917.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Tools & Accessories, Limited, 4, Tudor Gardens, West Acton, London, W.—Capital, £1,000. Directors: J. and N. Downs.

H. S. Bagshaw & Son, Limited, 235, High Street, Rochester, Kent—Capital, £2,000. Metal workers. Directors: N. L. and V. Bagshaw.

Metal Residues (Port Talbot), Limited, Talbot Wharf, Aberavon, Port Talbot—Capital, £10,000. Directors: F. A. Best and M. A. Leonard.

H.V.H. Engineering Company, Limited—Capital, £3,000. Directors: E. R. Voigt, 29, Manor Road, Hereford; C. Hughes, H. Hiles and J. J. Hiles.

Wm. Tagg & Company, Limited, 36-38, Sutton Street, Newcastle-under-Lyme—Capital, £5,000. Founders and engineers. Directors: G. and J. F. Tagg.

Heat Pumps, Limited, Capel House, 54, New Broad Street, London, E.C.2—Capital, £1,000. To acquire inventions relating to utilising industrial waste heat, etc.

Swarf, Limited, Groveland House, Bow Lane, London, E.C.4—Capital, £1,000. Metal and scrap merchants, etc. Directors: F. C. S. London and J. D. Macmillan.

Clarke Bros. (Engineers), Limited—Capital, £500. Directors: F. J. Clarke, 90, Moston Lane East, New Moston, Manchester; S. J. Clarke, G. A. Moorhead and H. Mansfield.

A. W. Trippas & Company, Limited, 16-17, Bath Street, Birmingham, 4—Capital, £7,500. Engineering specialists. Directors: A. W. and R. G. Trippas, A. A. Kershaw and A. R. Murtagh.

Ellis Instruments, Limited—Capital, £1,000. Instrument and tool makers, etc. Directors: H. C. E. E. Maconochie, 145, London Road, Kingston-on-Thames, and J. E. Ellis.

Jonstead, Limited—Capital, £1,000. Tool designers and makers, manufacturers of metal utensils, etc. Directors: M. Jones and E. S. Griffiths, 26, Pendennis Road, London, N.17.

Fletcher Bros. (North Western), Limited, 71, Northwestern Street, Ardwich, Manchester, 12—Capital, £5,000. Manufacturing and general engineers. Directors: E. J. Fletcher and H. Hibbert.

Spenstead Industrial Equipments, Limited—Capital, £500. Manufacturers of sand-blast and dust-extraction equipment, etc. Director: W. M. Oddie, Quarry Close, Northfield Lane, Horbury.

Rhodes, Gill & Company, Limited—Capital, £5,000. To take over an engineering business carried on in Yorkshire. Directors: L. Rhodes, 163, Stanningley Road, Armley, Leeds; C. E. and A. H. Rhodes.

J. K. Smit—Enwood, Limited—Capital, £8,000. Engineers, manufacturers of tools and machinery for the diamond industry, etc. Directors: J. K. Smit, Grosvenor House, Park Lane, London, W.1; R. W. Asquith, E. J. Edward, and J. H. Husbands.

Reports and Dividends

Churchill Machine Tool Company, Limited—Final dividend of 15 per cent. (same), making 30 per cent. (same).

W. Canning & Company, Limited—Final dividend of 5 per cent., making 10 per cent. (same) and a bonus of 2s. per share (same).

Vulcan Foundry, Limited—Net profit for 1940, after tax, £29,528 (against £48,172); dividend of 3 per cent. on the ordinary shares (against 5 per cent. for 1939).

G. Beaton & Son, Limited—Profit for 1940, before providing for taxation, £55,518 (against £46,319); dividend of 10 per cent. and a cash bonus of 5 per cent. (same).

Ransomes & Rapier, Limited—Net profit for 1940, £17,592 (£22,502); final dividend of 3 per cent., free of tax, on the ordinary shares, making 6 per cent., free of tax, for 1940 (against 6½ per cent., free of tax, for 1939).

Imperial Chemical Industries, Limited—Net income for 1940, after approximately £5,600,000 for N.D.C. and E.P.T. (against £2,500,000 in 1939), £2,000,000 for obsolescence and depreciation (same), and after providing for income-tax, £6,418,533 (£7,313,485); to war contingency reserve, £339,262 (against £1,000,000); to workers' pension fund, £180,092 (£180,049); preference dividend, £1,666,104 (same); ordinary dividend of 8 per cent. (same), £4,032,149; brought in, £681,428; carried forward, £882,354.

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Raw Material Markets

There continues to be a very insistent demand for low-phosphorus and hematite pig-iron, and producers are hard pressed to satisfy orders from essential consumers. Very little iron can be released for other users, and a certain amount of foreign iron is being distributed where home output is insufficient to cope with urgent demands. High-phosphorus iron, which is produced from home ores, is in ample supply despite increased use of this grade by heavy engineering foundries. The position of the light-castings foundries remains variable; as yet, only a comparatively small proportion of the firms in this branch has become fully associated with the war effort.

Pig-Iron

MIDDLESBROUGH—Trading conditions in the pig-iron market are nowadays of a very formal character, all transactions being subject to licences issued by the Iron and Steel Control. Producers, for their part, are required to comply with delivery instructions of the Control, and are thus no longer obliged to discriminate between the various classes of users. Licences have been issued for the second quarter of the year and buyers have lost no time in placing orders covering this period. Consumption of high-phosphorus iron among the light-castings foundry trade is relatively small, as, also, is the output in the Cleveland area, so that practically all requirements have to be satisfied by makers in the Midlands.

Production of hematite is fully absorbed by users engaged on war work, and licences cover only the bare needs of these concerns. Even with strict control of distribution the necessity for importing iron cannot be obviated, but the use of foreign material is being restricted to very urgent demands, and every encouragement is given to buyers of hematite to minimise the quantities used in their mixtures. Naturally, there are limits to the extent to which hematite requirements can be reduced, but the present policy, which has been dictated by force of circumstances, is proving satisfactory.

LANCASHIRE—Heavy engineering establishments, which are mostly solely employed on Government work, have never before been so busy for so long a period as has been the case during the past year or so, and it is unlikely that there will be any slackening of operations until the war has been brought to a successful conclusion. Consumption of pig-iron among these concerns is, of course, at a high level, consumers being covered by licence over the second quarter of the year. Common foundry grades of iron for jobbing and light-castings foundries is in moderate demand, although the position of these consumers is not really satisfactory, especially in the latter section. Refined irons are being taken up steadily.

MIDLANDS—Much more business is required by the light foundry industry, which has so far failed to acquire sufficient orders from Government purchasing agencies to make up for the considerable volume of lost peacetime trade. Thus, demand for high-phosphorus iron from this quarter is not substantial, although more is being taken up by heavy engineers, the latter being urged by the Control authorities to utilise this iron in their mixtures as freely as possible owing to the relative scarcity of low-phosphorus, hematite and other better-grade irons. Essential needs of the special-quality irons are being covered where necessary by the allocation of imported material, but consumption is being kept down as much as possible.

SCOTLAND—The pig-iron market here is unchanged, with heavy engineers absorbing the bulk of the iron reaching this area. These priority users would welcome much larger tonnages than are at present arriving, as existing circumstances do not facilitate the accumulation of stocks, but urgent needs are promptly met. Basic iron for the steelworks is well taken up and the supply position appears to be somewhat easier, but the situation in regard to hematite is still on the tight side. Foundry iron for makers of light castings is being supplied satisfactorily by producers in the English Midlands; many consumers are by no means fully employed, so that consumption is well below peak levels.

Coke

Ample supplies of foundry coke are being delivered to buyers, who have been given the opportunity to put down stocks. Coke makers, although doing a good inland trade, inevitably feel the loss of export markets. For delivery to Birmingham and Black Country stations, the current price of Durham best foundry coke is 61s. 6d. per ton, while the f.o.t. quotation is 45s. 6d. per ton.

Steel

The expansion in the Government's shipbuilding programme is calling for larger tonnages of plates, sections, joists, etc., which are also being taken up on a heavy scale by wagon, tank and boiler manufacturers. Structural engineers have recently been somewhat less active, but during the past week or so slightly busier conditions have been reported and have been reflected in the demand for steel. Light sections are moving away quite steadily, while the call for black and galvanised sheets is still keen.

Scrap

An urgent demand for iron and steel scrap embraces a wide range of qualities and descriptions. While delivery specifications tend to increase, the supply position does not appear to improve very much and, generally speaking, there would be ready disposal of much larger tonnages. In many instances steelmakers are taking up mixed iron and steel scrap when they are unable to obtain the steel scrap usually utilised for the production of steel.

Metals

Tin—A firmer tone has been in evidence on the London tin market since the Easter holidays, chiefly because of an advance in the East and an improved demand from the United States. Very heavy sales have lately been recorded in the Eastern market, about 2,300 tons having changed hands in one week, compared with only a few hundred tons the previous week. The activity is believed to have been due to delay in the issue of licences for sales from the mines during the present quarter. A London firm is understood to have received an order from the U.S. Navy for 250 tons of tin for shipment from the East. The American market has been quite brisk and the spot quotation has moved up to 52.25 cents per lb., with forward quoted at 51.625 cents.

The Board of Trade has notified the London Metal Exchange that no licences will be issued in respect of shipments of tin to the United States during May. It is probable that this decision is due to Bolivian ore shipments to this country having been subject to delay.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £271 to £271 10s.; Friday, £271 15s. to £272; Monday, £271 to £271 10s.; Tuesday, £271 to £271 10s.; Wednesday, £270 15s. to £271.

Three Months—Thursday, £267 10s. to £267 15s.; Friday, £266 15s. to £267; Monday, £267 to £268; Tuesday, £267 to £267 5s.; Wednesday, £266 15s. to £267.

Copper—Ever-increasing tonnages of copper are being called for by the war industries, and deliveries are satisfactory. The position of non-essential users is unenviable, as little metal can be released for purposes not associated with the war effort.

The American Copper Institute announces that production of crude copper in the United States in March was 85,643 short tons, against 79,093 tons in February. Production of refined was 95,322 tons (93,654); deliveries to domestic consumers, 134,333 tons (112,808); export shipments, 6 tons (11); and refined stocks at the end of the month, 89,873 tons (97,689).

Spelter—It is necessary to exercise caution in the distribution of zinc owing to our dependence upon imported metal. At the same time, there is no shortage for priority consumption, and all demands in this category are being given prompt attention.

Lead—Supplies of this metal are quite satisfactory, as many sources of demand have dried up or, at any rate, diminished since the outbreak of war. House building, particularly, has been affected. Nevertheless, the Control are watching the position carefully.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

529,331 Boucher, J., and Soc. Anon. des Hauts Fourneaux et Fonderies de Pont-a-Mousson. Installation for the transverse reinforcement of pipes and other pieces.

529,398 Consolidated Mining & Smelting Company of Canada, Limited. Electrodeposition of manganese.

529,463 Electro Metallurgical Company. Alloys.

529,497 Westfalia Dinnendahl Groppel Akt.-Ges. Treatment of dross in flotation plants.

529,504 Electro Metallurgical Company. Alloys.

529,508 Snow, C. I., Pierce, I. T., and Imperial Chemical Industries, Limited. Treatment of metal-bearing surfaces.

529,530 International de Lavaud Manufacturing Corporation, Limited. Wheel mounting for centrifugal casting-machine.

529,573 Ellis, L. S. E. (Lindemuth, L. B.). Manufacture of iron or steel.

529,655 Smith, W. H. Apparatus for vibrating moulds and the like.

529,680 International de Lavaud Manufacturing Corporation, Limited. Centrifugal mould and supporting jacket therefor.

529,709 Bengough, G. D. Means for the protection of surfaces against corrosion by liquids.

529,735 Sedzimir, T. Rolling-mills and automatic compensation of deflections.

529,772 Brassert & Company, Limited, H. A. (Brassert, H. A.). Bessemer production of steel.

529,825 Udylite Corporation. Electro-deposition of nickel.

529,891 Andersson, F. S. Electric salt-bath furnaces.

529,916 Hilgers Maschinen- und Apparate-bauanstalt Ges. Device for introducing tubes into tube-bending machines.

529,944 Alloy Research Corporation. Polishing of stainless iron and steel.

529,991 Parsons & Company, Limited, C. A., and Smith, R. H. Casting of metal objects.

530,006 Pyrene Company, Limited. Improving the resistance of metals to corrosion.

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